IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

ARM LTD., a U.K. corporation, Plaintiff, v. QUALCOMM INC., a Delaware corporation, QUALCOMM TECHNOLOGIES, INC., a Delaware corporation, and NUVIA, INC., a Delaware corporation, Defendants.	C.A. No. 22-1146-MN **PUBLIC REDACTED VERSION** (Filed July 22, 2024)

DECLARATION OF NICHOLAS FUNG IN SUPPORT OF ARM LTD.'S MOTIONS TO EXCLUDE AND STRIKE CERTAIN EXPERT OPINIONS OF MURALI ANNAVARAM, PATRICK KENNEDY, JOHN COATES, AND JOEL STECKELARM

VOLUME 1 OF 4 (EXHIBITS 1-5)

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DECLARATION OF NICHOLAS FUNG IN SUPPORT OF ARM LTD.'S MOTIONS TO EXCLUDE AND STRIKE CERTAIN EXPERT OPINIONS OF MURALI ANNAVARAM, PATRICK KENNEDY, JOHN COATES, AND JOEL STECKEL

I, Nicholas Fung, declare as follows:

1. I am an attorney with the law firm of Morrison & Foerster LLP ("Morrison & Foerster"), counsel for Plaintiff Arm Ltd. ("Arm") in the above-referenced action.

2. I submit this declaration in support of Arm's Motions to Exclude the Expert Opinions of Murali Annavaram, Patrick Kennedy, John Coates, and Joel Steckel.

3. Attached hereto as **Exhibit 1** is a true and correct copy of the Opening Expert Report of Dr. Robert Colwell, dated December 20, 2023.

4. Attached hereto as **Exhibit 2** is a true and correct copy of the Opening Expert Report of Dr. Mike Chen, dated December 20, 2023.

5. Attached hereto as **Exhibit 3** is a true and correct copy of the Opening Expert Report of Mr. Todd Schoettelkotte, dated December 20, 2023.

6. Attached hereto as **Exhibit 4** is a true and correct copy of the Opening Expert Report of Mr. Guhan Subramanian, dated December 20, 2023.

7. Attached hereto as **Exhibit 5** is a true and correct copy of the Opening Expert Report of Dr. Ravi Dhar, dated December 20, 2023.

8. Attached hereto as **Exhibit 6** is a true and correct copy of the Opening Expert Report of Dr. Murali Annavaram, dated December 20, 2023.

9. Attached hereto as **Exhibit 7** is a true and correct copy of the Rebuttal Expert Report of Dr. Murali Annavaram, dated February 27, 2024.

10. Attached hereto as **Exhibit 8** is a true and correct copy of the Rebuttal Expert Report of Dr. Patrick Kennedy, dated February 27, 2024.

11. Attached hereto as **Exhibit 9** is an excerpt of a true and correct copy of the deposition transcript of John Coates, taken on April 19, 2024.

12. Attached hereto as **Exhibit 10** is a true and correct copy of the Expert Rebuttal Report of Mr. John Coates, dated February 27, 2024.

13. Attached hereto as **Exhibit 11** is a true and correct copy of the Expert Rebuttal Report of Dr. Joel Steckel, dated February 27, 2024.

14. Attached hereto as **Exhibit 12** is a true and correct copy of the Reply Expert Report of Dr. Murali Annavaram, dated March 25, 2024.

15. Attached hereto as **Exhibit 13** is a true and correct copy of the Opening Expert Report of Dr. Patrick Kennedy, dated May 20, 2024.

16. Attached hereto as **Exhibit 14** is an excerpt of a true and correct copy of the deposition transcript of Dr. Murali Annavaram, taken on June 27, 2024.

17. Attached hereto as **Exhibit 15** is an excerpt of a true and correct copy of the deposition transcript of Dr. Robert Colwell, taken on June 28, 2024.

18. Attached hereto as **Exhibit 16** is a true and correct copy of the Reply Expert Report of Mr. Todd Schoettelkotte, dated June 10, 2024.

19. Attached hereto as **Exhibit 17** is a true and correct copy of the Reply Expert Report of Mr. Guhan Subramanian, dated March 25, 2024.

20. Attached hereto as **Exhibit 18** is a true and correct copy of an email exchange from June 2021 and November 2022, with the subject line "[redacted]," produced by Defendants with Bates number QCARM_7434227.

21. Attached hereto as **Exhibit 19** is a true and correct copy of an email exchange from May 2021, with the subject line "[redacted]" produced by Defendants with Bates number QCARM_3535535.

22. Attached hereto as **Exhibit 20** is a true and correct copy of the Expert Reply Report of Dr. Patrick Kennedy, dated June 24, 2024.

23. Attached hereto as **Exhibit 21** is a true and correct copy of an email exchange from July 2021, with the subject line "Follow up," produced by Arm with Bates numbers ARM_01305785 to - ARM_01305789.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

Executed this 10th day of July, 2024 at Los Angeles, California.

/s/ Nicholas Fung
Nicholas Fung

CERTIFICATE OF SERVICE

The undersigned hereby certifies that on July 10, 2024, a copy of the foregoing document was served on the counsel listed below in the manner indicated:

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Exhibit 1

IN THE UNITED STATES DISTRICT COURT
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ARM LTD., a U.K. corporation, Plaintiff, v. QUALCOMM INC., a Delaware corporation, QUALCOMM TECHNOLOGIES, INC., a Delaware corporation, and NUVIA, INC., a Delaware corporation, Defendants.	C.A. No. 22-1146 (MN) **CONTAINS HIGHLY CONFIDENTIAL – SOURCE CODE-ATTORNEYS' EYES ONLY**

OPENING EXPERT REPORT OF DR. ROBERT P. COLWELL

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I. INTRODUCTION

1. My name is Dr. Robert P. Colwell, and I have been retained as an expert witness on behalf of the Plaintiff Arm Ltd. in this matter. I understand that Arm has sued Defendants Qualcomm Inc., Qualcomm Technologies, Inc., and Nuvia, Inc. in the District of Delaware in the case captioned *Arm Ltd. v. Qualcomm Inc. et al.*, No. 1-22-cv-001146-MN (D. Del.). I am being compensated for my time in connection with this proceeding at $650/hour. My compensation is not dependent on the substance of my opinions, my testimony, or the outcome of this proceeding.

2. I have been asked to analyze whether certain Qualcomm CPU cores incorporate technology developed by Nuvia under the Nuvia Architecture License Agreement ("Nuvia ALA"), [redacted]

3. As discussed further below, it is my opinion that:

(i) The [redacted] core initially developed by Nuvia (a) was designed to be [redacted]; (b) implements the Arm instruction set and other components of [redacted]; and (c) was [redacted]

(ii) Qualcomm incorporated substantial parts of the Nuvia-designed [redacted] core into later versions of the [redacted] core used in certain Qualcomm

System-on-Chip ("SoC") products, including the [redacted].

(iii) While I understand that Qualcomm claims it swapped out certain Arm IPs from its products following Arm's termination of the Nuvia licenses, the documents and testimony provided by Qualcomm indicate that [redacted]

4. I base my opinions on my extensive experience in the industry; experience with Arm technology; my review of documents produced in this litigation; my review of deposition transcripts; my review of discovery responses; a conversation I had with Arm Chief Architect Richard Grisenthwaite on December 13, 2023; source code produced by Qualcomm; and other materials. I also reviewed the Expert Report of Dr. Shuo-Wei (Mike) Chen submitted in this case. I include a list of materials considered in Appendix A to this report.

II. EXPERIENCE AND QUALIFICATIONS

5. I am a technical expert in the field of computer engineering and microprocessor design. I am also an industry expert in those fields. I attach a copy of my *curriculum vitae* as Appendix B to this report, which describes my relevant experience, including academic and employment history, publications, professional activities, and speaking engagements.

6. I received a B.S. degree in Electrical Engineering from the University of Pittsburgh in 1977. I received an M.S. degree in Computer

Engineering from Carnegie Mellon University (CMU) in 1978, followed by a Ph.D. in Computer Engineering from CMU in 1985.

7. From 1977 until 1980 I worked for Bell Laboratories in Holmdel, New Jersey as a hardware design engineer developing 8- and 32-bit microprocessors. My specific responsibilities included design and support of their in-circuit emulators, and design and timing analysis of interchip signaling protocols.

8. From 1980 until 1984, while obtaining my Ph.D., I worked part time for Perq Systems in Pittsburgh, Pennsylvania, as a hardware design engineer working on high-resolution graphics display hardware for first generation bit-slice-based workstations.

9. From 1985 until 1990, I worked at Multiflow Computer in Branford, Connecticut, as a hardware design engineer creating the world's first VLIW (very long instruction word) scientific supercomputer. Multiflow sold about 125 such systems at an average selling price of $200K.

10. From 1990 to 2001, I held various positions at Intel Corp. in Hillsboro, Oregon, including Senior CPU Architect and Chief Architect (for Intel's IA-32, also known as x86). As part of my responsibilities at Intel, I co-invented Intel's P6 microarchitecture, productized as the Pentium Pro, which also formed the core of the Pentium II, the Pentium III, Celeron, Xeon, and Centrino families, as well as the Pentium 4. P6 microarchitecture features are still very influential today in Intel's top-of-the-line Core i3, i5, i7,

i9, and X-series processors. In addition, I led Intel's overall x86 Pentium CPU architecture endeavors across multiple chip developments. I was honored to be named an Intel fellow in 1997 in recognition of my contributions to the P6 microarchitecture development. Overall, I worked with and spent 11 years leading a large industrial microprocessor design team at Intel, which by the late 1990s included more than 850 engineers.

11. Along with the x86 chip development work, in my role as Intel's Chief Architect, I also tracked current and emerging competition in the microprocessor product space. Although Arm Inc. products were not performance-competitive with Intel's chips in the 1990's, I paid attention to Arm because my personal conviction in the late 1990's was that low-power and low-cost processors would increasingly be required in the future mobile computing platforms that I was sure would emerge (which turned out to primarily take the form of smartphones and tablets). I analyzed the ARM instruction set, core performance, and software tool availability (compilers, debuggers, simulators), as well as projected licensing costs and support models. The conclusion I reached at the time, and still hold today, is that a capable design team could use the ARM instruction set to design Arm-compliant processors that would challenge the best processors from Intel

or AMD in every market segment. My conclusion ended up being correct, as evidenced by Apple's introduction of the M-series processors.[1]

12. While at Intel, I also paid attention to Qualcomm, because I found it worrisome that we at Intel had a processor product line that had little to offer the coming mobile computing markets. Intel had no suitable x86 cores to sell to those low-power markets, and no ability to license x86 cores to Qualcomm, even if we had those cores in our product line. Given Qualcomm's long history in the cell phone industry, which is necessarily a mobile and battery-operated environment, the SoC paradigm looked to be a natural fit to serve as the basis for those mobile products. SoCs are space-efficient, incorporating most of the necessary system functions on a single chip, and power-efficient because electrical interconnections are short and the SoC designers can optimize the SoCs' functions rather than having to use whatever is available. SoCs require, among other things, one or more CPUs, each with one or more processor cores. Licensing cores from a company dedicated to developing those cores is an effective solution compared to creating and permanently maintaining a CPU core development team so that each new generation remains performance competitive.

13. I became a self-employed industry consultant in 2001, working with computer industry clients such as Safeware, the University of

[1] Hassan Mujtaba, *Apple M1 ARM 8 Core CPU Is Faster Than Intel & AMD's Fastest 8 Core Chips in Single-Core Performance Benchmark*, WCCFTECH (March 25, 2021), https://wccftech.com/apple-m1-arm-8-core-cpu-faster-intel-amd-fastest-8-core-chips-single-core-performance/ (last visited December 19, 2023).

Pittsburgh, Intel, venture capital companies, various expert witness engagements, and the U.S. Department of Defense (DoD).

14. In 2011, I joined DoD's Defense Advanced Research Projects Agency (DARPA) as deputy director of the Microsystems Technology Office (MTO). DARPA is the U.S. government's premier defense-related funding agency, specializing in high-risk and high-reward technologies for the U.S. military. A year later I became MTO's director, until my departure in April 2014. MTO had an annual budget of approximately $600M, and my job as office leader was to invest that money in promising new technologies for the DoD, including new energy-efficient computing systems, modular and adaptable radars, position/navigation/timing systems for GPS-denied environments, computer-mediated prosthetics for military (and civilian) amputees, traumatic brain injury detection devices for soldiers, fused multiple-band night vision sensors, extremely high-power lasers, and much more.

15. I have authored numerous publications including books, chapters in books, journal papers, and numerous patents (40) associated with computer hardware and processor design. My *curriculum vitae* includes a list of all the publications I have authored in the last 10 years. Many of these publications concern the design of microprocessors and computer systems. I have also been an editor for Institute of Electrical and Electronics Engineers (IEEE) publications, as well as a columnist and author.

16. I have received multiple awards, including the 2005 Eckert-Mauchly Award for “outstanding achievements in the design and implementation of industry-changing microarchitectures.” The Eckert-Mauchly Award is generally viewed as the highest recognition in the field of computer architecture. In 2006, I was elected to IEEE Fellow and inducted into the National Academy of Engineering for contributions to turning novel computer architecture concepts into viable, cutting-edge commercial processors. In 2012, I was inducted into the American Academy of Arts and Sciences (AAAS). Other inductees in my AAAS “class” that year included Sir Paul McCartney, Hillary Rodham Clinton, and Mel Brooks. In 2015, I received the Bob Rau Award from the IEEE for “contributions to critical analysis of microarchitecture and the development of the Pentium Pro processor.”

III. BACKGROUND AND OPINIONS

A. Microprocessor Industry

17. A microprocessor is a computer on an integrated circuit, also known colloquially as a “computer chip.” The “micro” part of the word “microprocessor” refers to the physical size of the processor. At the time the term microprocessor was coined (1971), computer systems were the size of several full-sized refrigerators, while the microprocessor was the size of a pack of chewing gum. Regardless of size, all such processors can fetch and execute machine instructions from main memory. A microprocessor is also known as a “CPU,” or Central Processing Unit. A new term for

microprocessors, “core,” has come into vogue since the burgeoning number of transistors afforded by Moore’s Law enabled the industry to put more than one CPU onto a single integrated circuit. By convention, the product is still called a microprocessor, but there can be multiple cores within that processor, each capable of independently fetching and executing its own instruction stream. These multiple independent cores may share certain facilities such as a common cache, an on-chip network, access to main memory, and an input/output interface.

18. Other components of a modern computer system, such as those in a smartphone, can also be integrated onto the same silicon as the cores, yielding a product conventionally called a System-on-Chip, or SoC.

19. Microprocessors and SoCs are now ubiquitous in everyday life and are no longer found just in computer systems, phones, and tablets. Modern automobiles have many different processors, from entertainment systems, security systems, engine controllers, antilock brake controllers, transmission controllers, to the key fob that opens the doors. Likewise, today’s homes are rife with computing horsepower: processors run the microwave, washing machine, dryer, furnace, TV, router, cable modem, and even light switches and flashlights.

20. The International Trade Commission (ITC) estimates the size of the global information technology (IT) sector to be $5T and more than 10% of

the U.S. gross domestic product.[2] Several of the largest companies in the world are heavily IT-centric. By some metrics, Apple is #1 with the largest market cap at $2.65T. Microsoft is #3 with a market cap of $2.1T, Alphabet (Google) at #4 with $1.54T, Amazon at #5 with $1.42T, NVIDIA with $1.06T, Tesla at #6 with $910B. By contrast, Toyota, a more conventional manufacturing company, has a market cap of $236B. The entire U.S. movie industry revenue in 2022 was $41.7B, and the music industry at $19.1B in 2020, while the high-tech video game market was valued at $159.3B in 2020, three times higher than movies and music combined.[3]

21. It is important to realize that new computer technology does not just afford incremental improvements to existing products or markets, but also enables entirely new markets and products. For instance, the Internet came into existence when computers became fast enough, and inexpensive enough, to handle the data traffic. Smartphones became feasible products when processors became fast enough to execute useful applications at power levels that did not quickly drain the battery.

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[2] David Coffin et al., *The Roadblocks of the COVID-19 Pandemic in the U.S. Automotive Industry*, U.S. INTERNATIONAL TRADE COMMISSION (USITC) (June 2022), https://www.usitc.gov/publications/332/working_papers/the_roadblocks_of_the_covid-19_pandemic_in_the_automotive_industry_final.pdf (last visited December 19, 2023).

[3] Gavin Divers, *Gaming Industry Dominates as the Highest-Grossing Entertainment Industry*, GAMERHUB (January 24, 2023), https://gamerhub.co.uk/gaming-industry-dominates-as-the-highest-grossing-entertainment-industry/#:~:text=To%20put%20that%20in%20perspective,much%20as%20the%20movie%20industry (last visited December 15, 2023).

2. Microprocessor Architectures.

22. A computer instruction set architecture (ISA) is the list of instructions that a compatible processor is able to execute, plus other information needed by an assembly language programmer, such as the number and width of the machine's registers, addressing modes, control register descriptions, supported data types (*e.g.*, integers, single and double precision floating point, and strings), as well as the actual bit-for-bit encoding of the instructions.

23. A computer instruction is an operation that a given processor "knows how to perform," encoded into a pattern of bits that the processor can decode and execute. A canonical example might be an integer add instruction. For the Arm ISA, the corresponding "opcode" would be called ADD, and the overall instruction would specify the two source registers whose contents are to be added together, plus a destination register indicating where the sum is to be written. If the data to be added happened to reside in main memory, two memory loads would have to first be performed to get the data into the registers. The much more complicated Intel x86 architecture, by contrast, allows the ADD instruction itself to access memory for one of the source values, and the destination can also be memory.

24. ISAs such as Intel's x86 architecture comprise hundreds (or thousands, depending on how one counts) of instructions, which include simple instructions but also much more complicated operations that require microcode (a kind of computer-within-the-computer code) for their

implementation. This type of ISA is known as complex instruction set computers (CISC).

25. Originally, Arm's ISA had only a few dozen instructions and adhered to a design philosophy known as reduced instruction set computers (RISC). Subsequently, the Arm ISA has added several hundred more instructions with Armv8. The Arm ISA can directly access 16 registers from user mode, while the x86 architecture has only 4 such registers, with a few others that are dedicated to certain activities, plus some vestigial segment registers. Arm has two operating modes, user and privileged, while x86 has a more elaborate ring mechanism.

26. Below is a screenshot of a few exemplary instructions from the Arm A64 Instruction Set (described in the Arm ARM), including the ADD instruction previously discussed. The ADD instruction, as discussed above, simply adds two data values together and puts the sum into a destination register. (The "immediate" tag on these particular instructions signifies that one of the data values to be added is not in a register but is contained within the instruction encoding itself, making it "immediately" available to the hardware adder.) The ADDS instruction does exactly the same operation as ADD, but also sets some one-bit result (also called "status") flags such as Zero, Negative, Carry, and Overflow. The SUB and SUBS instructions are just like ADD/ADDS except that they perform subtraction instead of addition. Compare instructions set the result flags according to whether one data value

is larger or smaller than the other one, and the result flags are generally used by subsequent conditional branches.

Table C3-42 Arithmetic instructions with an immediate

Mnemonic	Instruction	See
ADD	Add	*ADD (immediate)* on page C6-883
ADDS	Add and set flags	*ADDS (immediate)* on page C6-891
SUB	Subtract	*SUB (immediate)* on page C6-1455
SUBS	Subtract and set flags	*SUBS (immediate)* on page C6-1466
CMP	Compare	*CMP (immediate)* on page C6-982
CMN	Compare negative	*CMN (immediate)* on page C6-976

Figure 1: Arithmetic Instructions from Arm A64 Instruction Set. (ARM_01324149 at -390.)

27. The Intel x86 ISA evolved largely as a competition between one generation of CPUs and the next generation – if a new Intel chip was not compellingly faster than the existing one, the new one would not command a profit margin high enough to underwrite the next generation of fab equipment. While Intel chip designers still had to balance multiple competing factors in creating a new chip, such as performance, power dissipation, product cost, schedule, and risk of design errata, performance generally came first among design goals. It was my experience that the last 10% of performance gain in a design comes at a disproportionately large cost in power and design effort. The Arm ISA, by contrast, explicitly aimed to enable compatible implementations that emphasized good performance at

outstanding power efficiency, an excellent recipe for the computational elements underlying smartphones and tablets.

28. Developing a new ISA requires achieving a subtle and extremely complex balance among many competing concerns. Beyond a minimal set of instructions that any ISA would be expected to have (integer ADD, for example), designers could choose to add more instructions, attempting to provide hardware to support high-level functions in the user code for best performance. But it can be difficult for a compiler to spot opportunities to use those specialized instructions, and meanwhile, the bit encodings of the instructions will be necessarily larger, thus potentially compromising other aspects of the machine, such as cache performance. It is also quite easy to (intentionally or otherwise) embed certain aspects of the current microarchitecture into the ISA itself, which then requires all future implementations of that ISA to re-implement them, possibly to their detriment.

29. But perhaps the biggest challenge facing an ISA designer has to do with his or her motivation for attempting a new ISA design in the first place. There would have to be some very compelling reason why that designer believes it would be worth the enormous expense and risk of attempting to develop a custom ISA. That designer must therefore achieve the delicate balance required of any ISA while also maintaining the compelling innovation aspect of the new ISA, along with development of the

software tools (itself a gargantuan task), documentation, training, and creation and maintenance of validation suites. Another way to look at this is that, even if an existing ISA is not perfect for a particular implementation and therefore foregoes some potential performance or power savings, it is not a given that a new ISA could do so much better that performance alone could be a sufficient motivation for a new ISA development. In my career, I have had the opportunity to help develop a new ISA (at Bell Labs and Multiflow Computer), and as Intel's chief x86 architect, I oversaw the addition of hundreds of new instructions to x86 to keep the performance of x86 chips competitive. Indeed, the x86 ISA was considered doomed in the 1980s by most computer architecture researchers, who believed it was too archaic even then to remain competitive. Forty years later, with continuous development, it is still one of the most popular and profitable ISA for servers, desktops, and laptops.

30. Most system architects choose to license existing ISAs for the CPU parts of their new product. Rather than waste time and incur project risk by developing a new ISA, they can invest their limited time and resources in optimizing other essential aspects of the system: cache design, placement, policies, sizes and speeds; memory size, controller features, and power/performance tradeoffs; system power management and power-efficient operating states; and hardware accelerators for important functions or emerging applications. When they finish and begin marketing their new

CPU, being able to stamp the Arm-compliant imprimatur can be extremely valuable, because it raises the confidence of a prospective CPU purchaser concerning the maturity of the design, the tools available (and quality thereof), what backup plans might be feasible, and much more.

31. While SoC technology has been around since the 1970s, continuing advances in chip implementation technology, combined with steadily increasing user expectations, have converged to make SoCs the technology of choice. An SoC is at the heart of every smartphone, Apple or otherwise. An SoC, as exemplified below,[4] is a combination of IP blocks for specific functions, comprising such modules as one or more CPU cores, a graphics processor, DRAM interfaces, a power management unit, and various I/O standard interfaces, all on a single chip.

[4] *NVIDIA and Qualcomm ARM Up Against Competitors*, BERKELEY DESIGN TECHNOLOGY, INC. (October 18, 2011), https://www.bdti.com/InsideDSP/2011/10/20/NvidiaQualcomm (last visited December 19, 2023).

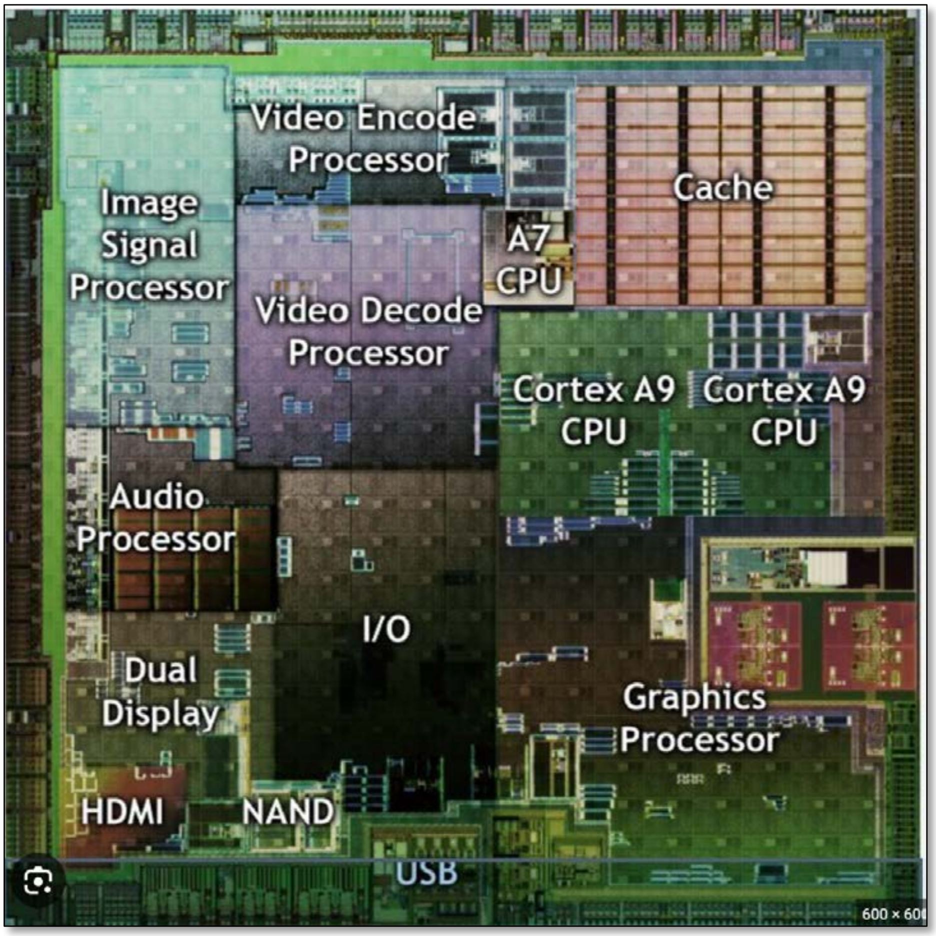

Figure 2: SoC showing various IP blocks and two CPU cores.

32. Systems with as many required features as modern SoCs rely heavily on industry standards to help manage that complexity. Today's SoCs have several different radio transmitter/receivers, and each of them corresponds to an industry standard, so that the final SoC will allow the user to successfully contact the cell phone tower, the local WiFi network(s), and a Bluetooth device attempting to pair with it. Similarly, there are industry standards for touchscreens, USB cables, batteries, chargers, and many other aspects of an SoC-based product. From a product designer's point of view, being compatible with communications standards is absolutely required:

buyers of their product will expect their new smartphone to reliably talk to cell phone towers using the appropriate cell phone radio protocols, send and receive data (and device charging current) via a USB cable, connect to nearby printers and headphones via Bluetooth, and so on.

33. One of the other choices the SoC designer will make concerns the ISA of the general processor (or processors, in the case of multiple cores) on the SoC. They will choose one of three options: (1) adopt an existing ISA such as Arm's ISA; (2) start with a "blank sheet" and design their own ISA (the "full custom" option); or (3) start with an existing ISA and modify it. The full custom option (2) is much more expensive than the other two, both in design and software tools support, and is risky. The first option is the most expedient and has a great deal to recommend it – for a reasonable licensing fee, the designer can license a known-working core (such as an Arm-designed core) that is compatible with the desired ISA, along with the software tool chain required to use it. There is broad industry acceptance of (1), as numerous companies license cores from Arm, including Nuvia, which had a TLA agreement. Some customers may want to add some feature or instruction to an existing ISA (option (3)), which retains the advantages of option (1) at a small cost in new software tool development, potentially resulting in a valuable product differentiation opportunity, but at the cost of additional development and permanent maintenance overhead.

34. The CPU is often described as the “brains” of a system. It executes a program that allows it to control the SoC: it oversees management of the battery subsystem, it runs whatever application(s) the user has indicated, it controls the display and reads the touchscreen inputs, and so on. CPUs work by “fetching” or retrieving an instruction from memory, decoding that instruction, performing the indicated operation, and then deciding what instruction is to be done next (which is usually the next sequential instruction in memory).

35. The CPU is designed to correctly perform all instructions from an “instruction set” using various machine resources such as registers (fast temporary storage), control/configuration registers, operating system facilities such as translation lookaside buffers, main memory, and input/output (I/O). CPUs must also strictly follow the ISA’s design for how to handle faults (such as divide-by-zero errors) and illegal instructions.

36. An instruction set is a collection of instructions that the CPU can perform, along with whatever information an assembly language programmer would need. Aside from the list of valid instructions, an assembly language programmer would need to know how many registers there are and whether any of them have side effects. They would also have to know how the ISA handles “memory semantics” (special rules one must follow to successfully interact with main memory), supported data types (such as integer, floating point, and strings), and the maximum size of virtual

and physical addresses. If a designer is developing a custom CPU core that is compliant with a particular ISA, the CPU design will need to comply with the constraints and requirements of that ISA.

37. CPUs can only perform instructions from the set of instructions for which they were designed. An Arm-compliant CPU cannot execute code for an x86, nor can an x86 processor execute Arm code. Both Arm and x86 have their own lists of instructions, Arm's list being shorter than x86's, each instruction encoded in its own way. If a processor fetches an instruction, and upon trying to decode that instruction discovers that the fetched bit pattern does not correspond to any of the instructions it understands, then the processor will perform a special maneuver called an "illegal instruction trap" and will terminate the application in which the illegal instruction appeared. Due to these issues of compatibility, it is imperative for designers to adopt an ISA that is broadly used, like the Arm ISA.

38. A microprocessor's ISA is often referred to by the shorthand "architecture"; *e.g.*, one might speak of the Intel Architecture or Arm Architecture. It is important to realize that any given architecture can be implemented in any number of different ways, each of them delivering different combinations of performance, power, cost, and size, while remaining compliant with the ISA.

3. Microprocessor Development.

39. A CPU architecture can be viewed as an abstract set of rules describing the interface between hardware and software – the interface as

seen by an assembly-language programmer. A CPU *microarchitecture*, by contrast, is the set of hardware functional blocks and protocols between those blocks that jointly implement the CPU architecture. A given CPU architecture may be implemented in a microarchitecture that optimizes performance above all else, including at the expense of high power and high product cost which would make it suitable for supercomputers and high-end servers. Conversely, that same CPU architecture can be realized via a different microarchitecture optimized for low power and long battery life, as required by mobile platforms such as tablets, smartphones, and laptops.

40. A CPU microarchitecture is implemented in a specialized low-level programming language called register transfer language (RTL). Examples of RTL include Verilog and VHDL. During development of a CPU core, a computer engineer uses a computer workstation to write and edit the RTL, adding new features or fixing errors. Then her work would be combined with that of her co-designers to constitute the current design. After innumerable such edit/fix/add/test sessions, the aggregate design will have implemented all necessary functionality to be considered compliant with the intended ISA. Automated software tools then translate the RTL into circuits and interconnections on the actual silicon substrate.

41. While the designers are modifying their RTL to complete the design and remove errors, a validation team is testing that RTL against legacy tests, random tests, and test suites. Design errors caught during RTL

development are generally orders of magnitude less expensive to ameliorate than "bugs" that escape into product deployment. It is easy to overlook the crucial role that validation plays in a processor development. As one CAD vendor put it: "In the field of electronics . . . verifying a design is universally the most critical aspect of a project. This applies to microprocessor design as well. Microprocessor designers generally require more time to verify their design than all other [design] steps combined."[5]

42. It is not possible to test every bit pattern against every instruction against every possible exception condition – there are far too many combinations to try them all, even on the fastest computers. Instead, validation engineers use their intuition and experience to wield validation test suites, random testing, bespoke software tests, emulation systems, and large server farms, to help decide when a design has matured to the point where production can be considered. When the design team has finished RTL coding, and validation and management give the go-ahead, production commences.

43. Production consists of transferring the RTL database, through a set of electronic design automation tools, to a fabrication plant such as TSMC. There, the fab engineers will run the incoming RTL design through their own set of rigorous checks, looking for silicon design rule errors that

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[5] *The Microprocessor Chip: Design Guidelines, Functionality, and Characteristics*, CADENCE PCB SOLUTIONS (2020), https://resources.pcb.cadence.com/blog/2020-the-microprocessor-chip-design-guidelines-functionality-and-characteristics (last visited December 19, 2023).

would impact yield (such as on-chip wires that are too close together or inadequate power/ground planes). When the fab engineers are satisfied, the actual photochemical processing of making a silicon chip begins.

44. Silicon processing is performed on wafers, thin disks that can hold dozens or hundreds of individual chips. After many steps and having traversed many large photochemical "tools" within the fab, the wafer processing eventually completes. The fab then performs quick tests on each die on the wafer and marks any die that fails so that further effort will not be wasted on it. The remaining dice are cut from the wafer and tested further. Those that survive will be packaged for sale to customers.

4. Business Models for Licensing Microprocessor Architectures

45. As outlined above, SoC designers have several fundamental options to consider, including which ISA their CPUs will be compliant with. There are only a few available ISA choices: Arm, RISC-V, and potentially (in the future) x86.

46. Arm is the gold standard for licensing ISAs and ISA-compliant cores. It has been in the ISA business for 33 years and has successfully developed multiple versions of its ISA (the latest is version 9) and numerous Arm ISA-compliant cores. Where RISC-V is open-source, meaning all intellectual property within the ISA and tools are publicly available and royalty-free, Arm is closed-source: buy the license and use the tools, but be subject to Arm's license requirements. In exchange, the licensee gets

consultation, documentation, guidance, and a relatively low-risk development path.

47. There are other advantages to an Arm license. The first is the intangible benefit of partnering with a company that has helped many others develop a successful product in the high-tech marketplace, and therefore is in a good position to evaluate a licensee's plans for new features and technical risks. A second is Arm's comprehensive portfolio of available technologies for other aspects of the licensee's product, such as on-chip interconnects that work well with the Arm ISA, and extensive validation suites that not only check architectural compliance but also serve as a thorough check on basic correctness of a new CPU implementation. Indeed, when Arm judges a new processor to be Arm-compliant, it is not just the processor designer's reputation at stake, it is also Arm's own reputation, which is a valuable endorsement for a chip design company, especially one with no previous track record.

48. RISC-V is a new ISA contender that is currently emerging with one major selling point – it is free. As one designer put it, "[i]f you wanted to make a CPU and you're not AMD or Intel, there are two real choices: ARM and RISC-V."[6]

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[6] Matthew Connatser, *ARM vs. RISC-V: Is one better than the other?* DIGITALTRENDS (May 31, 2022), https://www.digitaltrends.com/computing/arm-vs-risc-v/ (last visited December 15, 2023).

49. RISC-V was designed from the start to be "open source" – freely available and usable now and in the future. Support for the RISC-V open-source ISA may carry challenges. When a bug is found in a core design or in a critical software tool, who fixes it, and on what schedule? If a required feature is currently missing from a tool, who will develop that feature and maintain it, and when? If support is needed by a designer who has questions, who provides reliable answers on an urgent basis? Are future-looking ISA extensions being actively researched so that the RISC-V ISA will become and remain competitive in the future? RISC-V advocates argue that ISA customization will be increasingly important in a power-constrained future. Detractors point out that there is no guarantee that such innovations will be generally available, there being no requirement that RISC-V users share their advances. Both sides cite "fragmentation" where open-source users all run off in different directions with little central coordination (witness the wild proliferation of various Linuxes). RISC-V argues that it's a good thing, allowing for innovation, while closed-source fans prefer standardization. All of this uncertainty adds up to considerable risk to a project development.

50. Qualcomm's Manu Gulati (co-founder of Nuvia) stated that [redacted]

[redacted]

51. Intel has announced that it will begin x86 core licensing soon, but for the past 30 years, it declined to make x86 available and guarded its ISA zealously, so whether reasonably priced x86 cores at competitive performance and availability will appear is currently unknown.

B. Parties

1. Arm

(i) Company Background

52. Arm was established in 1990 with the goal of developing computer processors that were highly power efficient. Prospectus[7] at 3. By the mid-1990s, Arm-based processors had gained traction in mobile phones due particularly to the energy efficiency of the processors. (*Id.*)

53. Arm's success with mobile phones has grown substantially over the years. Arm's technology is now present in 99% of the world's smartphones. As of the beginning of 2023, Arm estimates that its technology is present in 250 billion processors worldwide and that approximately 70% of the world's population uses Arm-based products. (*Id.* at 11.)

54. Arm is a major technology company, with annual revenue of approximately $2.6 billion and almost 6,000 full-time employees. (*Id.* at 12.)

[7] Arm Holdings plc., 95,500,000 American Depositary Shares (Representing 95,500,000 Ordinary Shares) (Form SEC-424B4) (September 13, 2023), https://www.sec.gov/Archives/edgar/data/1973239/000119312523235320/d550931d424b4.htm (last visited December 15, 2023) (hereafter "Prospectus").

About 80% of Arm's employees are devoted to research and development (R&D) (*id.*), and the company spends approximately $1.3 billion per year on R&D efforts (*id.* at 110). Arm has business relationships with some of the world's biggest technology companies, including Apple, Samsung, Amazon, Mercedes Benz, and Siemens AG. (*Id.* at 14.) Arm is an owner or co-owner of approximately 6,800 issued patents. (*Id.* at 20.)

(ii) Arm Architecture

55. Arm's R&D efforts include developing and improving the Arm architecture, which Arm licenses to customers who wish to develop their own Arm-compliant custom cores under an Architecture License Agreement (ALA). Arm also provides development tools to assist ALA customers with implementing the Arm architecture in custom Arm-compliant cores.[8]

56. The Arm architecture includes the set of instructions that an Arm-compliant processor must be able to execute. These Arm instructions form the basis of the ISA. In addition to the required instructions, the Arm ISA includes other information that is needed to execute the instructions, such as information about registers that store data, encoding of data, and supported data types. The Arm architecture further includes information about exception detection and handling addressing modes, memory access ordering, special register semantics, operating system support functions, control registers, rules for co-processors, context swap information,

[8] ARM, https://www.arm.com/products/development-tools (last visited December 15, 2023).

interrupts, breakpoints, boot procedures, privileged modes, various abort vectors, security features, fencing and atomic operation support, and memory alignment restrictions. Arm has offered a number of versions of its ISA over the years, with the latest being version 9.[9]

57. The Arm architecture is described in documentation provided by Arm, specifically the Arm Architecture Reference Manual, sometimes called the "Arm ARM." Arm also provides other documentation and technical support to its customers to help them develop processors that embody the Arm architecture and other Arm technology.

58. Based on my discussions with Arm Chief Architect Richard Grisenthwaite, the Arm ARM is the authoritative document that defines the Arm architecture. It is thousands of pages long and contains more information and detail than any engineering team could recall with precision. Thus, any engineering team designing a custom Arm-compliant core would need to regularly consult the Arm ARM and implement its contents in the RTL code design for the custom Arm-compliant core. Mr. Grisenthwaite noted that [redacted] The Arm ARM contains a great many technical details concerning the Arm architecture that need to be correctly implemented in a core for it to be Arm-compliant.

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[9] ARM, *Arm CPU Architecture: A Foundation for Computing Everywhere*, https://www.arm.com/architecture/cpu (last visited December 15, 2023).

59. The types of information included in the Arm ARM includes the number, types, and any special aspects of the general register set; an introduction to the architecture and the instruction set; a discussion of the Programmer's Model (general information for an assembly language programmer, such as modes, exceptions, and synchronization primitives); details of the memory hierarchy design, including caches, write buffers, exceptions, and the like; architectural provisions for incorporating co-processors; features and design choices built into the virtual addressing mechanism; extensive discussions about the new floating point vector instructions and their use; and coverage of the built-in Debug Architecture.

60. While the Arm ARM is a publicly available document, I understand that the technology described in the Arm ARM is protected at least by patents and copyrights, as discussed below. Even though it is publicly available, the Arm ARM is still the subject of license restrictions with individual customers. For example, version G.b of the Arm ARM (ARM_01324149) includes the following restrictions:

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(ARM_01324149 at -150.)

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(ARM_01324149 at -151.)

61. Arm updates the Arm ARM periodically as it continues to develop and improve upon the Arm architecture. Arm releases different versions of the Arm ARM to describe updated features. The second page of the document lists the various versions and identifies the changes from the prior version.

03 June 2016	A.j	Non-Confidential EAC	EAC release
30 September 2016	A.k	Non-Confidential Armv8.0 EAC	Updated EAC release
31 March 2017	B.a	Non-Confidential Armv8.1 EAC, v8.2 Beta	Initial release incorporating Armv8.1 and Armv8.2
26 September 2017	B.b	Non-Confidential Armv8.2 EAC	Initial Armv8.2 EAC release, incorporating SPE
20 December 2017	C.a	Non-Confidential Armv8.3 EAC	Initial Armv8.3 EAC release
31 October 2018	D.a	Non-Confidential Armv8.4 EAC	Initial Armv8.4 EAC release
29 April 2019	D.b	Non-Confidential Armv8.4 EAC	Updated Armv8.4 EAC release incorporating accessibility changes
05 July 2019	E.a	Non-Confidential Armv8.5 EAC	Initial Armv8.5 EAC release
20 February 2020	F.a	Non-Confidential Armv8.6 Beta	Initial Armv8.6 Beta release
31 March 2020	F.b	Non-Confidential Armv8.5 EAC, v8.6 Beta	Armv8.5 EAC release, initial Armv8.6 Beta release
17 July 2020	F.c	Non-Confidential Armv8.6 EAC	Initial Armv8.6 EAC release
22 January 2021	G.a	Non-Confidential Armv8.7 EAC	Initial Armv8.7 EAC release
22 July 2021	G.b	Non-Confidential Armv8.7 EAC	Updated Armv8.7 EAC release

(ARM_01324149 at -150.)

62. An ALA allows a customer to develop its own customized core that is compliant with the Arm architecture. Prospectus at 96. According to Mr. Grisenthwaite, [redacted]. [redacted]

[redacted]

63. I discussed with Mr. Grisenthwaite the types of support that Arm provides to its customers. He noted that [redacted]

(iii) Arm Processors

64. Arm also offers its customers a variety of Arm-developed processor products, including its Cortex CPUs, GPUs, Physical IP, System IP, Security IP, and Subsystems IP.[10] When a core is compatible with Arm, it can interoperate with other Arm-developed products. For example, the Nuvia/Qualcomm NCCs and SoCs included cores that interoperated with

[10] ARM, https://www.arm.com/products (last visited December 15, 2023).

other IP blocks from Arm. Thus, there is an ecosystem of Arm IP and tools from which those designing their own Arm cores can benefit. A company can license the Arm processor products and IP blocks under a Technology License Agreement ("TLA"). Prospectus at 96. Under a TLA, customers are provided with "off-the-shelf" Arm CPUs and IP blocks that are compliant with the Arm architecture.

65. Arm's Cortex CPUs include the Cortex-A, Cortex-R, and Cortex-M families. The Cortex-A processors are CPUs for general use with operating systems and third-party applications.[11] The Cortex-R processors are embedded processors for real-time digital signal processing and control.[12] The Cortex-M processors are microcontrollers.[13]

66. Arm's processors are used for many different applications in different markets, including consumer technologies (*e.g.*, personal computers, smartphones, tablets),[14] automotive,[15] cloud computing,[16] and Internet of Things (IoT).[17]

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[11] ARM, https://www.arm.com/product-filter?families=cortex-a&showall=true (last visited December 15, 2023).
[12] ARM, https://www.arm.com/products/silicon-ip-cpu?families=cortex-r (last visited December 15, 2023).
[13] ARM, https://www.arm.com/products/silicon-ip-cpu?families=cortex-m&showall=true (last visited December 15, 2023).
[14] ARM, https://www.arm.com/markets/consumer-technologies (last visited December 15, 2023).
[15] ARM, https://www.arm.com/markets/automotive (last visited December 15, 2023).
[16] ARM, https://www.arm.com/markets/computing-infrastructure (last visited December 15, 2023).
[17] ARM, https://www.arm.com/markets/iot (last visited December 15, 2023).

(iv) Arm Has a Large Patent Portfolio Covering Its Architectural Innovations

67. One of the ways Arm protects its proprietary technology is by seeking patent protection for its innovations. Prospectus at 148. As of March 31, 2023, Arm owns or co-owns approximately 6,800 issued patents and has approximately 2,700 pending patent applications worldwide. (*Id.*) The patents cover aspects of Arm's processor architecture and microarchitecture, including certain specific instructions. (*Id.*) By patenting its technology, Arm retains IP rights in the Arm architecture that it licenses to its customers, even while making the Arm ARM available to the public.

68. I spoke with Mr. Grisenthwaite regarding Arm's patent portfolio. He confirmed that Arm's patents cover aspects of the Arm architecture, including memory management for 64-bit addresses, memory stack protection, and circuits for efficient conditional execution of certain instructions.[18]

(v) Industry Adoption of Arm Architectures

69. Arm-based CPUs are the most popular and pervasive CPUs in history. Prospectus at 12. As I mentioned above, ARM-based CPUs are in 99% of the world's smartphones and Arm estimates that 70% of the world's population uses Arm-based products. Prospectus at 11. More than

[18] By way of example, Mr. Grisenthwaite identified the following U.S. patents that describe features in the Armv8 architecture: Nos. 9,753,724; 9,760,374; and 8,566,563.

260 companies report that they shipped Arm-based chips in the fiscal year ending on March 31, 2023, including the world's largest companies like Amazon, Google, AMD, Intel, MediaTek, NVIDIA, and Samsung. (*Id.*) The Arm architecture and Arm-based CPUs have been adopted throughout the industry.

2. Qualcomm

70. Qualcomm is a technology company whose primary focus is on developing and commercializing technology for mobile devices and other wireless products.[19] Qualcomm principally derives revenue from sales of its integrated circuit products, including its Snapdragon family of products, and licensing of its intellectual property. Qualcomm Annual Report at 8. Around 2017, Qualcomm sought to develop a custom Arm-based CPU for data centers. Qualcomm called the custom core "Falkor" and the related SoC "Centriq."[20] This effort was not ongoing at the time of the Nuvia acquisition, since the president of Qualcomm's data center business unit had left and the media reported that Qualcomm planned to offload the division.[21] (*See also* [redacted]) [redacted]

[19] Qualcomm, Annual Report (Form 10-K) (September 26, 2021), https://www.sec.gov/Archives/edgar/data/804328/000172894921000076/qcom-20210926.htm (last visited December 15, 2023) (hereafter Qualcomm Annual Report).

[20] *Introducing the Qualcomm Falkor CPU core: purpose-built for cloud workloads*, QUALCOMM, OnQ Blog (August 19, 2017), https://www.qualcomm.com/news/onq/2017/08/introducing-qualcomm-falkor-cpu-core-purpose-built-cloud-workloads (last visited December 15, 2023).

[21] James Morra, *With Future Uncertain, Qualcomm Loses Data Center President*, ELECTRICDESIGN (May 22, 2018), https://www.electronicdesign.com/markets/automation/article/21806539/with-future-uncertain-qualcomm-loses-data-center-president (last visited December 15, 2023).

[redacted]

3. Nuvia

a. Company Background

71. Nuvia was founded as a start-up in 2019 by ex-Apple engineers Gerard Williams III, Manu Gulati, and John Bruno.[22] Mr. Williams was previously an ARM fellow at Arm for twelve years ([redacted]) and was also the Chief Architect at Apple for the M1 processor, which was a custom Arm-compliant CPU for consumer devices like laptops. ([redacted]) Nuvia planned to design energy-efficient

[22] Danny Crichton, *Three of Apple and Google's former star chip designers launch NUVIA with $53M in series A funding*, TECHCRUNCH (November 15, 2019), https://techcrunch.com/2019/11/15/three-of-apple-and-googles-former-star-chip-designers-launch-nuvia-with-53m-in-series-a-funding/ (last visited December 15, 2023).

CPUs for data center servers based on the Arm architecture.[23] At the time, designing a processor for data centers would have expanded the market for Arm's technology, since the data center market was historically dominated by x86 architectures. ([redacted]) Nuvia named its custom Arm-based CPU core [redacted]

b. Nuvia's ALA and TLA

(i) Background of Nuvia's ALA and TLA

72. On September 26, 2019, Arm and Nuvia entered into both an ALA (ARM_00059183) and a TLA (ARM_00002988). On September 27, 2019, Arm and Nuvia entered into an Annex 1 for both the ALA (QCARM_0339310) and the TLA (ARM_00051126). On March 27, 2020, Arm and Nuvia entered into another Annex 1 for both the ALA (ARM_00057230) and the TLA (QCARM_3861394).

73. As I explained in § III.B.1.ii, above, ALAs generally provide the licensee with the right to develop and produce a custom core that is compliant with the Arm architecture.

74. I am not an expert on licensing, but I have reviewed the Nuvia ALA agreement (including both Annex 1 documents). As I understand it, the Arm-Nuvia ALA agreement gave Nuvia the right to design and market a custom Arm-compliant core under that agreement. The Arm-Nuvia ALA

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[23] Dean Takahashi, *Nuvia raises $240 million to design Arm-based CPUs for datacenters*, VENTUREBEAT (September 24, 2020), https://venturebeat.com/business/nuvia-raises-240-million-to-design-arm-based-cpus-for-datacenters/ (last visited December 15, 2023).

agreement provided Nuvia with access to [redacted]

(ii) Definition of [redacted]

75. The ALA defines the term [redacted] to mean [redacted] Section [redacted] of the March 27, 2020, ALA Annex 1 is entitled [redacted] and lists three categories of deliverables, reproduced below:

[redacted]

76. The March 27, 2020, ALA Annex 1 further breaks out these three categories into more specific deliverables. For example, [redacted]

[redacted]

77. According to my understanding from reviewing the documents, the March 27, 2020, ALA Annex 1 further explains that [redacted] As Mr. Grisenthwaite explained in his deposition, the ALA [redacted]

78. [redacted] for additional reasons. The March 27, 2020,

ALA Annex 1 further states that [redacted] encompasses a defined category referred to as [redacted] The term [redacted] includes the [redacted] Based on these additional definitions, it is my understanding that [redacted]

79. In addition to the Arm ARM, Section [redacted] of the March 27, 2020, ALA Annex 1 also lists two additional categories of information.

[redacted]

80. The [redacted]

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[redacted]

81. The [redacted] During CPU development, an Arm licensee would repeatedly [redacted]

[redacted]. Arm's Richard Grisenthwaite told me [redacted]

82. The [redacted]

83. Computer security has become an essential element of modern systems, particularly systems through which valuable information flows (such as credit card numbers or bank account data). These systems, including smartphones, are actively and routinely attacked, so in response, these information flows must be encrypted by the sender and decrypted by the receiver. Encryption and decryption algorithms are computationally quite intensive, yet must be performed quickly enough that system users do not become impatient. Arm has developed [redacted]

[redacted]

(iii) **Derivatives of** [redacted]

84. The Arm-Nuvia ALA includes the concept of a [redacted] The ALA provides the following examples of derivatives of [redacted] As a technical and industry expert, but not as a licensing expert, my understanding is that derivatives and embodiments of [redacted] would include [redacted]

85. At every step of CPU development, hundreds of decisions are made that balance the various project goals against the fixed requirements of the ISA. Nearly every aspect of the RTL implicitly reflects the influences of the [redacted] – [redacted] Arm also provides [redacted]

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[redacted]

86. My understanding is consistent with that of Mr. Grisenthwaite, who told me that [redacted] Similarly, I consider [redacted][24]

87. Likewise, if a licensee has chosen to implement [redacted], obviously the instruction decoder design will necessarily reflect that, since it has to detect and decode all CPU instructions. Beyond that, however, inclusion of [redacted] will impact the microarchitecture in several distinct ways that are unique to Arm-compliant CPUs: a [redacted]

[24] As I mentioned in § III.B.3.b.iv below, the termination provision of the Nuvia ALA states: [redacted]

(iv) Termination Provision

88. From my review of the documents, it is my understanding that [redacted] of the Nuvia ALA discusses Nuvia's obligations if Arm terminates the ALA. (ARM_00059183 at -196.) This section references the [redacted] definition, which I previously discussed:

[redacted]

(*Id.*)

89. From my review, I understand that [redacted] requires that upon termination of the ALA by Arm, Nuvia is required to [redacted] and to [redacted] As I explained in § III.B.3.b.iii, above, my understanding as a technical and

industry expert is that derivatives of [redacted] include [redacted]

C. Factual Background

1. Nuvia Develops the [redacted] in Compliance with the Arm Architecture

90. Nuvia developed an SoC codenamed [redacted] that was designed for the data center market. (QCARM_2402257 at -263.) [redacted] included a custom CPU core called [redacted] ([redacted]) Specifically, [redacted] included [redacted]

[redacted]

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[redacted]

91. Nuvia designed the [redacted] core in accordance with the [redacted] described in the Arm ARM. For example, the first page of each version of the [redacted] states that it [redacted]

92. [redacted]

[redacted]

93. [redacted]

94. [redacted]

95. [redacted]

2. Qualcomm Purchases Nuvia and Arm Objects

96. As I explained in § III.B.1.i, above, Arm established dominance in the mobile processor market in the 1990s and Arm remains recognized as the premier CPU provider for the mobile processor market.[25] Arm technology was in 90% of smartphones as far back as 2010, and its market share of the

[25] William Gayde, *How Arm Came to Dominate the Mobile Market*, TECHSPOT (December 24, 2020), https://www.techspot.com/article/1989-arm-inside/ (last visited December 15, 2023).

mobile processor market has only grown since then, with Arm "dominat[ing] the mobile processor market with almost every major release built on top of its architecture." (*Id.*)

97. Arm licensee Apple launched its M1 SoC on November 10, 2020,[26] designed for personal computers. The M1 SoC uses a custom Arm processor as opposed to an x86 processor from Intel.[27] The M1 was an instant hit, as it was touted as being more efficient, operating faster, and having a longer battery life than competing SoCs, all with the use of a custom Arm processor. (*Id.*)

98. The release of the M1 SoC catapulted Arm into the PC market, as the M1 SoC was quickly recognized as outperforming other SoCs on the market.[28] The Apple M1 has since been viewed as a game changer in the CPU processor world and has helped Apple capture over 21% of the global PC

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[26] APPLE, Press Release: Apple unleashes M1 (November 10, 2020), https://www.apple.com/newsroom/2020/11/apple-unleashes-m1/ (last visited December 15, 2023).
[27] Nermin Hajdarbegović, *Apple M1 Processor Overview and Compatibility*, TOPTAL, https://www.toptal.com/apple/apple-m1-processor-compatibility-overview (last visited December 15, 2023).
[28] Stephen Shankland, *Apple M1 Macs are kick-starting a new Arm-based PC era. Arm's CEO is optimistic*, CNET (January 13, 2021), https://www.cnet.com/tech/computing/apple-m1-macs-are-kick-starting-new-arm-based-pc-era-arm-ceo-is-optimistic/ (last visited December 15, 2023).

market.[29] With the expansion into the PC market, Arm is now recognized as a major player in designing CPU chips used in PCs.[30]

99. Following the rise of Apple's M1 chip, Qualcomm considered purchasing Nuvia, which was developing its own Arm-based custom CPU core. Less than one month after Apple announced the M1, [redacted]

[redacted]

[29] Urvish Mahajan, *Apple M1 — How Apple Silicon Changed the PC Industry*, MEDIUM (September 23, 2023), https://medium.com/@urvishmahajan/apple-m1-how-apple-changed-the-pc-industry-4a7c3c8a3d57#:~:text=The%20M1%20chip%20powered%20MacBook,Window's%20growth%20was%20just%206%25 (last visited December 15, 2023).
[30] Katie Tarasov, *How Arm is gaining chip dominance with its architecture in Apple, Nvidia, AMD, Amazon, Qualcomm and more*, CNBC (November 9, 2023), https://www.cnbc.com/2023/11/09/how-arm-gained-chip-dominance-with-apple-nvidia-amazon-and-qualcomm.html (last visited December 15, 2023).

100. A few weeks later, [redacted]

[redacted]

101. [redacted]

[redacted]

102. On January 13, 2021, Qualcomm announced that Qualcomm Technologies, Inc. was acquiring Nuvia for $1.4 billion. (QCARM_2423540.) [redacted]

103. [redacted]

[redacted]

104. [redacted]

105. [redacted]

106. [redacted]

[redacted] Qualcomm has represented to the media that "the creation of our custom CPU was started by Nuvia engineers while employed at Nuvia."[31]

107. On March 1, 2022, the Nuvia licenses terminated, along with the corresponding rights to use or sell products based on or incorporating Nuvia technology developed under those licenses. (QCARM_0338883.)

108. [redacted]

[redacted]

3. Qualcomm Incorporates Nuvia Cores Into Its Own Products

109. After acquiring Nuvia, Qualcomm incorporated Nuvia's work on the [redacted] into Qualcomm's own products. [redacted]

[31] Mark Hachman, *Qualcomm dubs Nuvia CPU '*[redacted]*' on track for 2023*, PCWORLD (November 17, 2022), https://www.pcworld.com/article/1382740/qualcomm-dubs-nuvia-cpu-[redacted]on-track-for-2023.html (last visited December 16, 2023).

[redacted] After the acquisition closed in March 2021, [redacted] Less than a year later, [redacted] In April 2022, [redacted] Given the short timing, I would expect that Qualcomm used Nuvia's pre-acquisition work on the [redacted] to further develop the [redacted] that was [redacted] Consistent with my expectations, Qualcomm representatives have been quoted in the press as saying that "the creation of our custom CPU was started by Nuvia engineers while employed at Nuvia."[32] Also, as described below, Dr. Chen's analysis of the RTL code for the [redacted] establishes that a significant portion of the [redacted] developed at Nuvia was incorporated into the later versions of the [redacted]re developed by Qualcomm.

110. [redacted]

[32] Mark Hachman, *Qualcomm dubs Nuvia CPU '*[redacted]*on track for 2023*, PCWORLD (November 17, 2022), https://www.pcworld.com/article/1382740/qualcomm-dubs-nuvia-[redacted]on-track-for-2023.html (last visited December 16, 2023).

[redacted]

111. [redacted]

[redacted]

112. From my review of this [redacted], it is my understanding that the [redacted] in [redacted] in [redacted], with [redacted] Another document, entitled [redacted]

[redacted]

113. The [redacted] document indicates that [redacted]

[redacted]

[redacted]

114. [redacted]

4. Qualcomm Releases Snapdragon X

115. On October 24, 2023, Qualcomm announced its new Snapdragon® X Elite platform of SoCs, with what it called its "custom integrated Qualcomm [redacted] CPU."[33] Qualcomm's attorneys represented that they produced source code corresponding to [redacted] is a brand name and does not refer to a specific project or piece of technology. Qualcomm has produced source code for the custom CPUs that will be sold under the [redacted] name." (10/26/2023 email from J. Braly to J. Li.) Based on these representations and the dates of the produced source code (*see* § IV.B, below), it is my understanding that the October 24, 2023 [redacted] corresponds to the Qualcomm [redacted] CPU announced on the same date, making the Snapdragon® X Elite platform of SoCs and Qualcomm [redacted]

5. Abbreviated Timeline of Events

116. Below is an abridged timeline of events for this case.

Date	Event
Feb. 2019	Gerard Williams III, John Bruno, and Manu Gulati found Nuvia.[34]

[33] QUALCOMM, Press Note: Qualcomm Unleashes Snapdragon X Elite: The AI Super-Charged Platform to Revolutionize the PC (Oct. 24, 2023), https://www.qualcomm.com/news/releases/2023/10/qualcomm-unleashes-snapdragon-x-elite--the-ai-super-charged-plat (last visited December 16, 2023).
[34] Dean Takahashi, *Nuvia raises $240 million to design Arm-based CPUs for datacenters*, VENTUREBEAT (Sept. 24, 2020), https://venturebeat.com/business/nuvia-raises-240-million-to-design-arm-based-cpus-for-datacenters/ (last visited December 15, 2023).

Sep. 27, 2019	Arm and Nuvia enter into the Architecture License Agreement (ALA) and the Technology License Agreement (TLA).[35]
Aug. 11, 2020	Nuvia announces the [redacted] core.[36]
Mar. 16, 2021	Qualcomm completes acquisition of Nuvia.[37]
Feb. 1, 2022	Arm notifies Nuvia that it intends to terminate the ALA and the TLA due to Nuvia's violation of the assignment provisions. The termination is to be effective as of Mar. 1, 2022.[38]
[redacted]	[redacted][39]
Mar. 1, 2022	Effective date of termination of Nuvia ALA and TLA.[40]
[redacted]	[redacted]
[redacted]	Arm issues the [redacted][42]
Aug. 31, 2022	Arm files a complaint against Qualcomm and Nuvia for breach of contract and trademark infringement in the U.S. District Court for the District of Delaware.[43]

[35] (QCARM_0337839; QCARM_0338297.)
[36] Matthew Connaster, *Nuvia Announces CPI Codenamed* [redacted] *Promises to Deliver Leading Single Threaded Performance*, ADOREDTV (August 11, 2020), https://adoredtv.com/nuvia-announces-cpu-codenamed-[redacted]-promises-to-deliver-leading-single-threaded-performance/ (last visited December 20, 2023).
[37] (QCARM_2402586.)
[38] (QCARM_0338883.)
[39] (QCARM_0557206.)
[40] (QCARM_0338883.)
[41] (QCARM_3433989.)
[42] (QCARM_0190735.)
[43] (ARM_00045395.)

IV. FURTHER OPINIONS[44]

A. The [redacted] Cores Were Designed as [redacted] and Are [redacted] of [redacted]

1. Relevant Technical Definitions from Nuvia ALA and Annex.

117. The Nuvia ALA Annex ("Nuvia Annex") defines [redacted] to mean [redacted]

118. Section [redacted] of the Nuvia Annex lists [redacted] that I understand was conveyed by Arm to Nuvia, including [redacted]

119. The Nuvia Annex defines [redacted] to include [redacted]

[44] In addition to my opinions set forth in § IV, I note that I have provided some opinions in the Background (§ III). I incorporate any opinions from the Background (§ III) into the Opinion (§ IV).

120. The Nuvia Annex defines [redacted] to mean [redacted]

121. The Nuvia Annex defines an [redacted] to mean, [redacted] The conditions, reproduced fully below, broadly require that [redacted]

Specifically, [redacted]

[redacted]

122. The [redacted] referred to above are [redacted] The [redacted] is [redacted]

123. While the ALA's termination provisions apply directly to [redacted] and [redacted] the Nuvia ALA also defines [redacted] to include [redacted]

2. The Nuvia [redacted] Core and Later Versions of the [redacted] Core Were Designed to Implement the Elements of the Armv8 Architecture.

a. Nuvia decided to create a custom core based on the Arm architecture.

124. Since its founding, Nuvia's vision was to create an enterprise-level data server processor using [redacted]

125. [redacted]

[redacted]

b. [redacted]

(i) [redacted]

126. [redacted] The [redacted]

(ii) [redacted]

127. [redacted]

[redacted]

> [redacted]

[redacted]

128. [redacted]

129. [redacted]

[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

[45] Requirements listed in Nuvia Annex [redacted]
[46] Support and implementations listed in the [redacted] (QCARM_3087757.)
[47] *Id.* at -772.
[48] *Id.* at -972.
[49] *Id.* at -772.

	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

130. [redacted]

[50] *Id.* at -813.
[51] *Id.* at -922.
[52] *Id.* at -773.
[53] [redacted]
[54] (QCARM_3087757 at -922.)
[55] *Id.* at -773.

[redacted]

131. As the above shows, Nuvia developed the [redacted] core to ultimately be an [redacted] As Mr. Grisenthwaite stated during our conversation, [redacted]

(iii) [redacted]

132. [redacted]

[redacted]

133. [redacted]

134. [redacted].

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

c. Nuvia utilized Arm materials to develop the [redacted] Core.

(i) Nuvia used [redacted] as defined in the ALA Annex to build the [redacted] Core.

135. The Nuvia ALA Annex Section [redacted] lists [redacted] I understand that Nuvia downloaded these documents and tools either online or through [redacted]

136. [redacted]

[redacted] As summarized by Mr. Grisenthwaite during our conversation, [redacted]

137. [redacted] I further discuss these verification tools and Nuvia's use of them below in § IV.A.3.a.

138. [redacted]

[redacted]

(ii) Nuvia also used other Arm documents, tools, and knowledge to build the [redacted] Core.

139. In addition to the [redacted] defined in the ALA Annex, Nuvia also used other Arm materials to develop [redacted]. According to [redacted] For example, Mr. Trivedi

downloaded [redacted] Similarly, Mr. Trivedi downloaded [redacted]

140. Aside from distinct Arm materials and tools, Nuvia also obtained Arm support and knowledge to develop the [redacted] core. (*See, e.g.*, ARM_00040395; ARM_00038935.) During my conversation with Mr. Grisenthwaite, he mentioned that [redacted] In 2020 and 2021, Nuvia/Qualcomm and Arm personnel

[redacted]

d. Nuvia and Qualcomm employees testified that the Phoenix Cores were designed to implement [redacted] and be Arm-compliant.

141. [redacted]

142. [redacted]

143. [redacted]

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144. [redacted]

145. [redacted]

146. [redacted]

147. [redacted]

148. [redacted]

3. The Nuvia [redacted] Core Was Validated as an [redacted].

a. Nuvia and Qualcomm used confidential Arm tools to verify the Nuvia [redacted] Core's compliance with [redacted]

149. In designing the Nuvia [redacted] core to be an Arm-compliant core, Nuvia had access to and utilized confidential Arm tools. [redacted]

150. [redacted]

151. [redacted]

[redacted]

152. [redacted]

153. These verification tools are not public. [redacted]

b. Arm validated the Nuvia [redacted] Core as an Arm [redacted]

154. [redacted]

[redacted]

155. [redacted]

[redacted]

B. Nuvia's Design of the [redacted] Core Is Incorporated into Several of Qualcomm's SoC Products.

156. As I explained in §§ III.C.1 and IV.A above, Nuvia worked on designing and developing a custom Arm CPU core called [redacted], which Nuvia worked to incorporate into an SoC called [redacted]. As I also explained in § III.C.3, after Qualcomm acquired Nuvia, Qualcomm incorporated the Nuvia [redacted] core into several of its SoCs, including the [redacted]. This is confirmed by the RTL code analysis described below.

157. I understand based on information from Qualcomm's attorneys (*see* 9/12/2023 email from J. Braly to F. Patel) and my own review of the RTL code that Qualcomm has produced the following RTL code in this litigation:

- [redacted]

[redacted]

158. Based on my review, I understand that [redacted]

159. I note that [redacted]

160. I understand that Arm asked Dr. Mike Chen to review the RTL source code produced by Qualcomm and prepare an expert report describing his analysis. Dr. Chen is a professor in the School of Electrical and Computer Engineering at the University of Southern California and has a Ph.D. in Electrical Engineering from the University of California at Berkeley.

161. I have reviewed Dr. Chen's expert report. In addition, on December 15 from approximately 9 a.m. to 4:30 p.m., I reviewed the source code produced by Qualcomm on the source code desktop, together with Dr. Chen. During that meeting, Dr. Chen showed me the source code produced by Qualcomm, explained the analysis that he performed, and described his findings.

162. As explained in § II, I am an expert in computer engineering and microprocessor design due to, among other things, my time as Chief Architect of the x86 at Intel. I have extensive experience writing and interpreting RTL. Based on my experience, my review of Dr. Chen's report, my discussions with Dr. Chen, and my own review of the RTL source code, I endorse the qualitative and quantitative conclusions from Dr. Chen's expert report, namely that: [redacted]

163. Specifically, I endorse and share Dr. Chen's conclusion that [redacted] As Dr. Chen notes in his report, and consistent with my review of

[redacted] As Dr. Chen's report shows, [redacted]

164. I endorse and share Dr. Chen's conclusions that [redacted] Using file comparison tools, Dr. Chen was able to show [redacted]

[redacted]

165. Dr. Chen also collected data comparing the Nuvia [redacted]

166. Thus, in view of Dr. Chen's report and my own scrutiny of the RTL code, it is my opinion that [redacted] Nuvia and Qualcomm designs

after [redacted], [redacted] For example, Dr. Chen found [redacted]

167. In view of Dr. Chen's report and my own code review, it is also my opinion that [redacted]

[redacted]

C. Qualcomm's Purported Swap Out [redacted]

1. Qualcomm's Swap Out Was in Response to Termination of the Nuvia Agreements

168. As discussed in § IV(A), the Nuvia [redacted] core was designed to be an [redacted]. I understand that, following Arm's termination of the Nuvia ALA and TLA on March 1, 2022, [redacted] I refer to this exercise as the "Swap Out," consistent with Qualcomm's terminology. [redacted] I have reviewed Qualcomm's responses to Arm's Interrogatory No. 5 in which Qualcomm describes the actions it undertook as part of the Swap Out.

169. I understand that when Arm terminated the Nuvia ALA and TLA, Arm asked Nuvia to [redacted] I understand that this language is based on Section [redacted] of the Nuvia ALA and TLA. (ARM_00059183; ARM_00002988.) By its request, Arm was asking Nuvia to: [redacted]

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[redacted]

170. [redacted]

171. [redacted]

2. The Swap Out [redacted]

172. Based on my review of documents and testimony, it appears that [redacted]

[redacted]

173. [redacted]

[redacted]

[redacted]

174. [redacted]

175. [redacted]

[redacted]

176. [redacted]

3. Qualcomm Did Not Discontinue Using the [redacted] Cores in [redacted] Following the Termination of the Nuvia Licenses

177. Qualcomm states that it performed the Swap Out to "comply with the termination provisions in Nuvia's license agreements" (ECF No. 18 at ¶ 231), but the Swap Out [redacted]

178. [redacted]

[redacted] The evidence and RTL code analysis shows, however, that Qualcomm continued to use one significant derivative of [redacted][56]

179. As discussed in § IV.A above, the Nuvia [redacted] core was developed as an [redacted] based on information in the [redacted]

180. [redacted] of Section [redacted] of ALA Annex 1 list the various pieces of [redacted] supplied under the Nuvia ALA, [redacted] Nuvia employees received this information. For example, a download log shows that [redacted]

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

56 [redacted]

[redacted]

181. [redacted]

182. Accordingly, the Swap Out did not [redacted]

V. CONCLUSION

183. My opinions above are based on available information to date. I reserve the right to supplement or amend my opinions in this report, and also

to rebut opinions by Qualcomm's experts with which I disagree. I also reserve the right to correct any clerical errors that I discover after service of this report.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct. Executed on this 20th day of December of 2023 in Portland, Oregon.

By: ____________________________

Dr. Robert P. Colwell

APPENDIX A
LIST OF MATERIALS CONSIDERED

All documents cited within this report.
Technical Expert Report of Dr. Michael Chen.
Qualcomm Source Code computer.
Correspondence dated 10/26/2023, email from J. Braly to J. Li.
Correspondence dated 9/12/2023, email from J. Braly to F. Patel.

PLEADINGS

Arm Ltd. v. Qualcomm Inc. et al., No. 1-22-cv-001146 MN (D. Del.):

ECF No. 1, Complaint, dated August 31, 2022.
ECF No. 12, SEALED Defendants' Answer and Defenses to Plaintiff's Complaint and Jury Demand and Defendants' Counterclaim, dated September 30, 2022.
ECF No. 18, SEALED Defendants' Answer and Defenses to Plaintiff's Complaint and Jury Demand and Defendants' Amended Counterclaim, dated October 26, 2022.
ECF No. 23, SEALED Plaintiff Arm Ltd.'s Answer and Affirmative Defenses to Defendants Qualcomm Inc., Qualcomm Technologies, Inc., and Nuvia, Inc.'s Amended Counterclaim, dated November 15, 2022.

DISCOVERY

Defendants' Response and Objections to Plaintiff's First Set of Interrogatories (Nos. 1-13), dated February 27, 2023.

DEPOSITION TRANSCRIPTS REVIEWED[57]

Gulati Deposition Transcript dated October 12, 2023.
Amon Deposition Transcript dated November 15, 2023.
Trivedi Deposition Transcript dated October 25, 2023.
Williams Deposition Transcript dated November 3, 2023.
Asghar Deposition Transcript dated November 8, 2023.
Grisenthwaite Deposition Transcript dated November 15, 2023.
Bos Deposition Transcript dated November 29, 2023.
Thompson Deposition Transcript dated November 28, 2023.
Sharma Deposition Transcript dated October 27, 2023.
Kanapathipillai Deposition Transcript dated December 1, 2023.

PRODUCED MATERIALS

ARM_01324149	ARM_00051126	QCARM_3087757
ARM_00059183	ARM_00057230	QCARM_3087992
ARM_00002988	QCARM_3861394	QCARM_0325086
QCARM_0339310	QCARM_2402257	QCARM_0490031

[57] I had all deposition transcripts available to me.

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QCARM_0490329
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QCARM_3536689
QCARM_3536628
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QCARM_0027987
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Katie Tarasov, *How Arm is gaining chip dominance with its architecture in Apple, Nvidia, AMD, Amazon, Qualcomm and more*, CNBC (Nov. 9, 2023), https://www.cnbc.com/2023/11/09/how-arm-gained-chip-dominance-with-apple-nvidia-amazon-and-qualcomm.html (last visited December 15, 2023).

Mark Hachman, Qualcomm dubs Nuvia CPU '[redacted] on track for 2023, PCWORLD (Nov. 17, 2022), https://www.pcworld.com/article/1382740/qualcomm-dubs-nuvia-cpu-[redacted]

QUALCOMM, Press Note: Qualcomm Unleashes Snapdragon X Elite: The AI Super-Charged Platform to Revolutionize the PC (Oct. 24, 2023), https://www.qualcomm.com/news/releases/2023/10/qualcomm-unleashes-snapdragon-x-elite--the-ai-super-charged-plat (last visited December 16, 2023).

Hassan Mujtaba, *Apple M1 ARM 8 Core CPU Is Faster Than Intel & AMD's Fastest 8 Core Chips in Single-Core Performance Benchmark*, WCCFTECH (March 25, 2021), https://wccftech.com/apple-m1-arm-8-core-cpu-faster-intel-amd-fastest-8-core-chips-single-core-performance/ (last visited December 19, 2023).

David Coffin et al., *The Roadblocks of the COVID-19 Pandemic in the U.S. Automotive Industry*, U.S. INTERNATIONAL TRADE COMMISSION (USITC) (June 2022), https://www.usitc.gov/publications/332/working_papers/the_roadblocks_of_the_covid-19_pandemic_in_the_automotive_industry_final.pdf (last visited December 19, 2023).

NVIDIA and Qualcomm ARM Up Against Competitors, BERKELEY DESIGN TECHNOLOGY, INC. (October 18, 2011), https://www.bdti.com/InsideDSP/2011/10/20/NvidiaQualcomm (last visited December 19, 2023).

The Microprocessor Chip: Design Guidelines, Functionality, and Characteristics, CADENCE PCB SOLUTIONS (2020), https://resources.pcb.cadence.com/blog/2020-the-microprocessor-chip-design-guidelines-functionality-and-characteristics (last visited December 19, 2023).

Matthew Connaster, *Nuvia Announces CPI Codenamed Phoenix, Promises to Deliver Leading Single Threaded Performance*, ADOREDTV (August 11, 2020), https://adoredtv.com/nuvia-announces-cpu-codenamed-phoenix-promises-to-deliver-leading-single-threaded-performance/ (last visited December 20, 2023).

Appendix B

ROBERT P. COLWELL

3594 NW BRONSON CREST LOOP
PORTLAND, OR 97229
503-629-9638
BOB.COLWELL@GMAIL.COM

PROFESSIONAL EXPERIENCE

- **Director**, Microsystems Technology Office, DARPA Arlington VA 2012-2014
- **Deputy Director**, Microsystems Technology Office, DARPA 2011-2012

  Led office of 17 program managers, budget ~$600M/yr, funding research on computer systems, nanophotonics, bioengineering, radar, comms, lasers, IR imaging, and much more.
- **Consultant**, Portland, OR 2001-2011, 2014 - present

  General computer HW/SW consulting to industry and academia (Safeware, the University of Pittsburgh, Intel, Qualcomm, venture capital companies, many startups, expert witness engagements, Lawrence Berkeley National Lab, US DoD)

- Named an **Intel Fellow** (27 Fellows in Intel's employee population of ~80,000) in 1997; winner of 2005 **Eckert-Mauchly Award**, highest award in field of computer architecture, for "outstanding achievements in the design and implementation of industry-changing microarchitectures, and for significant contributions to the RISC/CISC architecture debate"; elected to **IEEE Fellow** and **the National Academy of Engineering** in 2006 (the highest recognition in field of engineering) for "contributions to turning novel computer architecture concepts into viable, cutting-edge commercial processors." Inducted into the **American Academy of Arts and Sciences**, 2012. Winner of **IEEE Bob Rau Award**, 2015.
- **Chief IA-32 Architect**, Intel Corporation, Hillsboro OR, 1992-2001

  Lead IA32 architect, responsible for all of Intel's x86 Pentium CPU architecture efforts (direct management included 40 – 110 people): Pentium Pro, Pentium II, III, 4; Initiated and led Intel's Pentium 4 CPU development

- **Senior CPU Architect**, Intel Corporation, Hillsboro OR, 1990-1992

  One of three senior architects responsible for conceiving Intel's P6 microarchitecture, the core of the company's Pentium II, Pentium III, Celeron, Xeon, and Centrino families

- **Hardware Architect**, Multiflow Computer, New Haven, CT 1985-1990

  One of seven hardware engineers who created the world's first VLIW (very long instruction word) scientific supercomputer under direction of Josh Fisher

- **Hardware Engineer** (part-time) Perq Systems, Pittsburgh PA, 1980 - 1984

  Hardware design engineer working on graphics display hardware for first generation bit-slice-based engineering workstations

- **Member of Technical Staff**, Bell Telephone Laboratories, Holmdel, NJ, 1977-1980

  Hardware design engineer working on 8 and 32-bit microprocessors

EDUCATION

- **PhD in Computer Engineering**, Carnegie-Mellon University, 1985
- **MSEE** in Computer Engineering, Carnegie-Mellon University, 1978

- BSEE in Electrical Engineering, University of Pittsburgh, 1977

PUBLICATIONS

Wrote foreword to "Weaving High Performance Multi-Core Processor Fabric: Essential Insights to the Intel Quickpath Architecture", Maddox, Singh, Safranek, Intel Press 2009

National Research Council, The Future of Computing Performance: Game Over or Next Level?, Washington, D.C.: The National Academies Press, 2010.

VLIW: The Unlikeliest Architecture, IEEE Solid State Circuits News, 2009

Wrote intro to DE Shaw's article on the Anton molecular folding engine in CACM, July 2008

Contributed parameterized chapter 2 problem sets to Hennessy & Patterson's "Computer Architecture: A Quantitative Approach, 4th Edition" 2006

The Pentium Chronicles, IEEE/Wiley, December 2005

IEEE Computer Magazine, 48 columns for "At Random" column 2002-2005

Wrote foreword to Josh Fisher's book "Embedded Computing: A VLIW Approach to Architecture, Compilers and Tools", Morgan-Kaufman 2005

We May Need A New Box, IEEE Computer March 2004

Superscalar Processor Design, P6 chapter, Shen & Lipasti, McGraw-Hill 2003

Embedded Everywhere, National Academy of Science, October 2001

Intel's College Hiring Methods and Recent Results, Microelectronics Systems Education Conference, Robert Colwell, Gary Brown, Frank See, July 1999

Microprocessor, Wiley & Son Technical Encyclopedia, 1999

Challenges and Trends in Processor Design, roundtable discussion in IEEE Computer, January 1998

A 0.6um BiCMOS Processor with Dynamic Execution, Robert P. Colwell, Randy L. Steck, 1995 IEEE International Solid State Circuits Conference, pp. 176-177 (won best paper award)

Latent Design Faults in the Development of Multiflow's TRACE/200, 22nd Annual International Symposium on Fault-Tolerant Computing, Boston MA, July 1992

Architecture and Implementation of a VLIW Supercomputer, Robert P. Colwell, W. Eric Hall, Chandra S. Joshi, David B. Papworth, Paul K. Rodman, James E. Tornes, Proceedings of Supercomputing '90, New York, November 1990

A VLIW Architecture for a Trace Scheduling Compiler, Robert P. Colwell, Robert P. Nix, John J. O'Donnell, David B. Papworth, Paul K. Rodman, IEEE Trans. on Comp., V. 37, N. 8, Aug.1988

A VLIW Architecture for a Trace Scheduling Compiler, Robert P. Colwell, Robert P. Nix, John J. O'Donnell, David B. Papworth, Paul K. Rodman, Proceedings of the 2nd Int'l Conf. on

Architectural Support for Programming Languages and Operating Systems, Oct. 1987, Palo Alto CA (2021 Winner of Influential Paper Award from ASPLOS Conference)

Fast Object-Oriented Procedure Calls: Lessons from the Intel 432, Edward F. Gehringer, Robert P. Colwell, ISCA 13, June 1986, pp. 92-101

The Performance Effects of Architectural Complexity in the Intel 432, Robert P. Colwell, Edward F. Gehringer, E. Douglas Jensen, ACM Transactions on Computer Systems, Aug. 1988, V. 6, N. 3

A Display Architecture for Driving Two Different Bitmapped Displays from One Frame Buffer, Robert P. Colwell, 1st Int'l Conference on Computer Workstations, San Jose CA, November 1985

Computers, Complexity, and Controversy, R.P. Colwell, C.Y. Hitchcock III, E.D. Jensen, H.M. Brinkley Sprunt, C.P. Kollar, IEEE Computer, September, 1985, pp. 8-19

The Performance Effects of Function Migration and Architectural Complexity in Object-Oriented Systems, Robert P. Colwell, PhD thesis, Carnegie-Mellon University, Pittsburgh, PA, August 1985

Peering Through The RISC/CISC Fog: An Outline Of Research, Computer Architecture News, Vol. 11, No. 1, March 1983 pp. 44-50

A Perspective on the Processor Complexity Controversy, Proceedings of the International Conference on Computer Design, 1983, pp. 613-616

The Origin of Intel's Micro-ops, invited paper, IEEE Micro 2021

LECTURES AND INVITED TALKS

P6: Myths and Pipelined Realities, MP Forum '95 in Santa Clara

Evolution of Slot 1 and Slot 2, MP Forum '97 in Santa Clara

Micro '30 keynote speaker, 1997, San Jose

HPCA2 keynote speaker, Santa Clara, 1996

Talks on computing futures at CMU and Oregon Graduate Institute, Intel's Design Test and Technology Conference 1997-1998 (best presentation DTTC), invited keynote DTTC '04

LCPC (Languages and Compilers for Parallel Computing) keynote speaker, San Jose 1996

Intel Research Forum invited speaker, Hillsboro '96, Santa Clara '99

Intel Distinguished Lecture Series talks on the Pentium Pro at BYU, MIT, UCB, Stanford, CMU, Illinois, Wisconsin, Univ of Washington, OGI, UCLA

Distinguished Lectures: UC Davis May 2003; Carnegie-Mellon Univ Nov. 2003; USC April 2004

Microprocessor Report dinner speaker on Pentium Pro, March '95

Neural Networks for Computing Conference, Snowbird Utah, April 1994

IEEE Winter VLSI Workshop 1995

DARPA Winter PI conference, Pasadena CA, January 1994

International Applications Conference, San Diego CA, June 1994

Nature's Paradigm and the Challenge of Validation, Intel Validation Summit 1998, invited talk

Validation Lessons from Elsewhere, Intel Validation Summit 1999, invited talk

ISCA keynote, Anchorage Alaska, June 2002

ECE380 Seminar invited talk, Stanford Univ. February 2004

Invited speaker, Technology Management Lecture Series, PSU May 2004

Invited speaker, CSE Division Wide Seminar, University of Michigan, January 2005

Invited keynote speaker, IEEE Int'l Symp. on Async Circuits and Systems, NYC, March 2005

Invited speaker, IEEE Management Series, Portland OR, April 2005

Eckert-Mauchly Award acceptance speech, ISCA, Madison Wisconsin, June 2005

Invited keynote, International Multiconference on Computer Science and Computer Engineering, Las Vegas NV, June 2005

Invited speaker: Google, Sun Labs, Portland State University 2005

Invited speaker: Cadence, Carnegie-Mellon Univ. CS, Univ. of Rochester, Walla Walla College 2006

Invited keynote, PICMET, Portland Oregon, August 2005

Distinguished lecture, Univ. of Utah, March 2006

Invited speaker: Computer Science Symposium, St. Petersburg, Russia 2006

Invited speaker, IEEE-CS 60th anniversary meeting, Santiago Chile, San Diego CA 2006

Invited speaker, National Academies "Distinguished Voices" lecture series, April 2007, Irvine CA

Invited speaker, FCRC "Future Of Computer Architecture 2007", June, San Diego CA

Invited keynote speaker, ASAP 2007 conference, July, Montreal Canada 2007

Invited speaker, UC Irvine, "How To Be a Successful Engineer", Feb. 2008

Invited speaker, US Naval Workshop on Ship Design, Williamsburg, VA May 2008

Invited speaker, DARPA DSRC summer session, Santa Cruz CA July 2008

Distinguished Hopeman Lecture, Grove City College, April 2009

Many invited talks as DARPA MTO spokesperson on the end of Moore's Law 2011-2014

Invited speaker, Microsoft Research 20th Anniversary Symposium, Sept. 2011

Invited speaker, Computer Science and Telecommunications Board (CSTB), Sept. 2011

Invited speaker, Secretary of Defense Corporate Fellows, July 2012, 2013

Invited speaker after-dinner talk, Salishan Conference on High Performance Computing, April 2013

Invited speaker, Industrial Physics Forum, Baltimore MD, March 2013

Invited speaker, Computing Community Consortium (CCC), Pgh PA, March 2013

Invited speaker, National Defense University College, Wash. DC, May 2013

Invited speaker, Design Automation Conference, Austin TX, June 2013

Invited keynote, Hot Chips Conference, Stanford, August 2013

Invited speaker, Gov't Forum on Moore's Law, Wash. DC, November 2013

Invited talks at UT Austin, seminar & computer architecture lecture, November 2013

Invited speaker, Rebooting Computing, Wash. DC, December 2013

Invited speaker, Dartmouth College, January 2014

Invited speaker, MIT Annual Research Conference (MARC), January 2014

Invited speaker, Virginia Tech Univ., February 2014

Invited speaker, Univ. of Rochester, March 2014

Invited speaker, IEEE Technology Time Machine conf, October 2014

Invited speaker, DARPA HAPTIX kickoff meeting, Arlington VA, Nov. 2014

Invited speaker, CSTB Continuing Innovation in IT workshop, Washington DC, Mar. 2015

Invited keynote, Stanford SystemX "Headlights" Workshop, April 2015

Invited keynote, Berkeley Energy Efficient Electronics Systems Symposium, Oct. 2015

Invited speaker, University of Washington, Nov. 2015

Invited speaker, Arizona State University, Feb. 2016

Invited keynote, DoE Extreme Heterogeneity workshop, January 2018

Invited keynote, DARPA NICE workshop, Feb. 2018 (Neuro-Inspired Computing Elements), Oregon

Invited keynote, ModSim workshop, Seattle, August 2018

ECE Commencement speaker, Portland State University, June 2019

Member, National Academy of Engineering review panel for NIST (National Institute of Standards and Technology) Nanotechnology Division, June 2021

Invited keynote, ModSim workshop, Seattle, August 2023

PANEL SESSIONS

DAC '91 panel session panelist; DAC '92 CAD tools workshop instructor

ICCD '91 moderator/organizer of panel session, San Jose CA

ICCAD-94, panel session panelist, November 1994, San Jose CA

Micro 26 '93, moderator/organizer of panel session, Portland OR

ISCA workshop talk, Santa Margerita Ligure, Italy 1995, panelist Phila. PA 1996

PAID 97 Workshop talk on "accidental performance decisions" with Dave Papworth

FPGA panel session panelist, November 1996, Monterey CA

ASPLOS-VII panel session panelist, October 1998, San Jose CA

IEEE Workshop on Low-Power design panel session, San Diego, CA 1999

Four panel sessions in 2000 at various conferences

Computer Research Assoc. "Grand Challenges" conference, Santa Cruz CA, Dec. 2005

DARPA MTO Exposition, Arlington VA July 2014

NSF Future Computing evaluation panel April 2018

ModSim 2018 panelist, Seattle WA

CONFERENCE COMMITTEES

ICCD 1990, 1991, 1992, 1993, 1994, 1995

IEEE Micro 24, 26, 27, 30, 31, 32, general co-chair 37, 39, 40, 41

ISCA 1999, 2000, 2008, 2009, 2010, 2015

Supercomputing 2013, 2014

TECHNICAL EXPERT LEGAL CASES WORKED

AVM v. Intel, Wilmer Hale, Lauren Fletcher, 2015-2017

Damages expert report, deposed, trial Wilmington DE May 2017

Futurelink v. Intel, Kirkland Ellis, Eric Cheng, 2014-2017

Invalidity, non-infringement expert reports, deposed 3 times, case settled 8/17/2023

Broadcom v. Renesas, Morrison Foerster, Fahd Patel, Daniel Muino, 2018-2020

Invalidity, non-infringement expert reports, deposed twice, testified at ITC hearing

Semcon v. Amazon, Sidley Austin, Tung Nguyen, Cal Butcher, 2019

Invalidity expert report, deposed 8/15/19, case settled

VLSI Tech. v. Intel, Wilmer Hale, Christine Duh, George Manley, Jordan Hirsch, 2017-2021

Damages expert report, Rebuttal report, deposed twice

CCO (Computer Circuit Operations) v Marvell, Sheppard Mullin, Wendy Cheung, 2020

Declaration filed, case settled August 2020

ACQIS v. Samsung, DLA Piper, Gianni Minutoli, 2021

Claim Construction declaration, deposed twice, case settled Dec. 2021

ACQIS v. Inventec, BlankRome, Greg Hermann, 2022

Damages & apportionment, case settled May 2022

Apple Inc. v. Future Link Systems, Inter Partes Review, EriseIP, Adam Seitz

IPR declaration filed, case settled April 2022

Apple Inc. v. Future Link Systems, Fish Richardson, John Brinkmann

Work on claim construction, case settled April 2022

ACQIS v. Microsoft, DLA Piper, Gianni Minutoli, 2022

Claim Construction declaration, case settled June 2023

OTHER

Selected as member of ISAT (Information Systems Advanced Technology) panel for DARPA, 2006-2009, co-chaired Machine Learning on Multicore 2009 with Carlos Guestrin and Greg Morrisett

Panelist, Dept of Defense Summer Study on Future Technology, summer 1999, Washington DC

CSTB Panelist, National Academy of Science, Networks of Embedded Processors, 1999-2000, Wash. DC

CSTB Panelist, National Academy of Science, Sustaining Growth in Computing Performance, 2006-2011, Wash. DC

IEEE Computer Magazine editor for High Performance Computing, 1995 to 1999

IEEE Computer Magazine editorial board member, Perspectives editor, 1999-present

Reviewer of dozens of technical books for Morgan Kaufmann, Mindshare, Addison-Wesley

Committee member on NSF funding for computer arch futures, Philadelphia, 1996

Intel Innovator's Day finalist '93, judge '95, judge '97

IEEE Senior Reviewer status in 1994, 1995, 1996 (conference papers, books, magazine articles)

Intel P6 public spokesman at dozens of radio, TV, and magazine interviews

Intel Divisional Award 1993 for DFA performance modeling tool

Intel Achievement Award 1996 for Pentium Pro Microarchitecture

CMU Alumni Merit Award, 1996, for technical leadership on Pentium Pro development

ACM Eckert-Mauchly award committee member, 1998-2001

Univ. of Pgh. Distinguished Alumni Award, 2000, for technical leadership on Intel's microprocessors

Univ. of Pgh. University Achievement Award, 2001, for accomplishments in field of Computing

Carnegie-Mellon Distinguished Alumni Fellows Award 2001

PICMET "Medal of Excellence" 2005

Judge for CSIDC (Computer Society Int'l Design Competition) 2005, 2006

Instructor ECE570, Adv. Computer Arch., Oregon State Univ., winter semesters 2000, 2003

Inventor or co-inventor on 40 patents

Exhibit 2

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

ARM LTD., a U.K. corporation,
Plaintiff,

v.

QUALCOMM INC., a Delaware corporation, QUALCOMM TECHNOLOGIES, INC., a Delaware corporation, and NUVIA, INC., a Delaware corporation,
Defendants.

C.A. No. 22-1146-MN

CONTAINS HIGHLY CONFIDENTIAL – SOURCE CODE-ATTORNEYS' EYES ONLY

OPENING EXPERT REPORT OF DR. SHUO-WEI (MIKE) CHEN
ON QUALCOMM SOURCE CODE

TABLE OF CONTENTS

ny-2648383

I. INTRODUCTION

1. My name is Dr. Shuo-Wei (Mike) Chen and I have been retained as an expert witness on behalf of the Plaintiff Arm Ltd. in this matter. I understand that Arm has sued Defendants Qualcomm Inc., Qualcomm Technologies, Inc., and Nuvia, Inc. in the District of Delaware in the case captioned *Arm Ltd. v. Qualcomm Inc. et al.*, No. 1-22-cv-001146-MN (D. Del.). Among other things, I have been asked to review source code produced by Qualcomm and Nuvia in this litigation and analyze (1) similarities between versions of source code and (2) inclusion of various features of Arm's architecture within the source code. I am being compensated for my time in connection with this proceeding at $650/hour. My compensation is not dependent on the substance of my opinions, my testimony, or the outcome of this proceeding.

II. BACKGROUND

2. I am a technical expert in digital, analog, and mixed-signal integrated circuit (IC) design. My expertise extends to Register-Transfer Level (RTL) code that is used in digital microprocessors and processors, digital ASICs, and system-on-a-chip (SOC) designs. RTL code, written in Hardware Description Languages (HDLs) like Verilog and VHDL, describe the functionality of hardware components that are ultimately fabricated on devices like processors and SOCs. I have attached my CV as Exhibit A to this report.

3. I graduated with a Bachelor of Science in Electrical Engineering in 1998 from National Taiwan University, where I was ranked number 1 in the upper division. I received a master's degree in Electrical Engineering and Computer

Science from the University of California, Berkeley in 2002. In 2006, I completed my Ph.D. in Electrical Engineering and Computer Science from the University of California, Berkeley.

4. I am currently a Professor of Electrical and Computer Engineering at the University of Southern California (USC). My current research involves building electronic circuits and systems that involve intensive digital signal processing, where RTL coding is an essential step for implementing the digital processor on our silicon chips. Prior to USC, I worked in industry for 5 years (2006-2011), building various SOC products that used microprocessors for communications. I have been a professor at USC since 2011.

5. I have engaged in projects and published papers that involved digital microprocessor/processor design. For example, I worked on an SOC product in industry that I described in a publication in ISSCC 2008 and JSSC 2008, entitled "A Dual-Band CMOS MIMO Radio SoC for IEEE 802.11n Wireless LAN." Another exemplary work involves a digital processor described in an ISSCC 2020 paper, entitled "A 40MHz-BW 76.2dB/78.0dB SNDR/DR noise-shaping nonuniform sampling ADC with single phase-domain level crossing and embedded nonuniform digital signal processor in 28nm CMOS." My work on these projects included writing a significant amount of RTL code.

6. I have received awards for my work and research. In 2023, I was elevated to IEEE Fellow (class of 2024) in recognition of my technical contributions in solid-state circuit society. In 2022, I was the co-recipient of the ISSCC Jack Kilby

Award for outstanding achievements in a circuit prototype that leveraged intensive digital signal processing. That same year, I was the co-recipient for the RFIC 2022 Best Student Paper Award for a circuit prototype that also leveraged digital signal processing techniques for a communication system. I was the IEEE Solid-State Circuit Society (SSCS) Distinguished Lecturer from 2021-2023. I have been invited to offer seminars, workshops, keynote talks, and panel discussions in major IEEE conferences, IEEE SSCS chapters, and universities regarding mostly digital circuit architecture for modern integrated circuit design, *i.e.* leveraging digital signal processors for improving the performance and/or reduce cost of the circuit and system.

III. MATERIALS CONSIDERED

7. In addition to my personal knowledge and expertise in the field, I have reviewed RTL source code produced by Qualcomm in this case. Based on my review of the source code and correspondence from Qualcomm's counsel (*see* 9/12/2023 email from J. Braly to F. Patel), I understand that Qualcomm produced source code for the following "list of SOCs and cores":

- [redacted]
    - [redacted]
    - [redacted]
    - [redacted]
    - [redacted]
- [redacted]
    - [redacted]

[redacted]

8. I have personally reviewed this source code on a desktop computer produced by Qualcomm in Los Angeles, CA on the following dates in 2023: September 15/19/21/22, October 3/4/5/12/13/16/19/20/25/26, November 13/17/20/28/29, and December 1/8/11/12/13/14/15/18. I have spent a total of approximately 160 hours reviewing source code in this case. I have requested that Qualcomm produce printed source code and have relied on the requested source code. Qualcomm has produced printed source code in this case beginning at Bates No: QSC1ARMVQ0000001 but has not completed producing the printed source code that I have requested as of my signing of this report.

9. I have also reviewed various additional materials in forming my opinions. I reviewed (1) Arm's Complaint filed in this case on August 31, 2022;

[1] The spelling is from 9/12/2023 email from J. Braly to F. Patel, but the correct spelling appears to be [redacted]

(2) the deposition transcripts of Qualcomm witnesses Gerard Williams, Manu Gulati, Nitin Sharma, Jignesh Trivedi, and Pradeep Kanapathipillai; and (3) the deposition transcript of Arm witness Richard Grisenthwaite. Counsel for Arm has provided me with access to all of the deposition transcripts in this litigation, which I have browsed through for background information about the litigation.

10. I have reviewed the following technical documents produced by Qualcomm and Nuvia:

[redacted]

11. I have included a list of materials considered as Exhibit B to this report.

IV. FACTUAL BACKGROUND

12. Based on my review of the factual materials listed above and public sources, I have the following understanding: Nuvia was founded in early 2019 by

three former Apple employees named Gerard Williams, Manu Gulati, and John Bruno.[2] Nuvia's goal was to develop a faster and more power-efficient CPU core for data center applications. The code name for this CPU core was [redacted]. Nuvia also developed an SOC called [redacted] that incorporated the [redacted] CPU core.

13. In December 2020, Nuvia provided a presentation to Qualcomm that included [redacted]

14. On January 21, 2021, Qualcomm announced an agreement to purchase Nuvia.[3]

15. On March 15, 2021, Qualcomm announced that it completed its acquisition of Nuvia.[4]

16. After the acquisition of Nuvia, the former-Nuvia employees now at Qualcomm [redacted]. In January 2021, when Qualcomm announced its agreement to acquire Nuvia, Qualcomm's CEO announced in an internal email that [redacted] After the acquisition closed in March

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[2] Stephen Nellis, *Former Apple chip executives found company to take on Intel, AMD*, REUTERS, https://www.reuters.com/article/us-nuvia-tech-idUSKBN1XP19V/?taid=5dcefd5c1dd1a30001b949f0&utm_campaign=trueAnthem%3A+Trending+Content&utm_medium=trueAnthem&utm_source=twitter (last visited December 18, 2023).

[3] QUALCOMM, Press Release: Qualcomm to Acquire NUVIA (Jan. 21, 2021), https://www.qualcomm.com/news/releases/2021/01/qualcomm-acquire-nuvia (last visited December 18, 2023).

[4] QUALCOMM, Press Note: Qualcomm Completes Acquisition of NUVIA (Mar. 15, 2021),https://www.qualcomm.com/news/releases/2021/03/qualcomm-completes-acquisition-nuvia (last visited December 18, 2023).

2021, [redacted]

17. Qualcomm developed several other SOCs containing versions of the [redacted] core: [redacted]

V. **ANALYSIS AND OPINIONS**

A. **Summary of Opinions**

18. I have been asked to perform both quantitative and qualitative substantive analyses of the RTL code produced by Qualcomm in this case. On the quantitative side, I have been asked to determine the extent to which source code developed by Nuvia prior to the Qualcomm acquisition is identical to source code in

Qualcomm's products.[5] Based on my analysis, and as further described below, it is my opinion that [redacted] I was also asked to compare [redacted] and I determined that [redacted]

19. On the qualitative side, I have been asked to identify some specific exemplary features of the Arm architecture in the [redacted] that are still present in SOCs/cores post-acquisition. Based on my analysis, and as further described below, it is my opinion that [redacted]

B. [redacted]

1. Summary of quantitative approach

20. I performed a quantitative analysis to determine the similarity of source code across different versions of code produced by Qualcomm using the following methodology.

[5] RTL code is written as text, so I was able to use computer tools to compare text files of RTL code to determine lines of code from versions of the same file that was literally identical to one another.

21. First, I relied on the technical documents produced by Qualcomm and Nuvia and the deposition testimony listed in § III to understand some background about Nuvia and Qualcomm's engineering efforts and their nomenclature. I learned that before the Qualcomm acquisition, Nuvia began working on a CPU core ultimately called [redacted]. [redacted] was a custom core that Nuvia designed to implement the Arm architecture and instruction set. Nuvia's design [redacted] Nuvia further designed an SOC intended for data centers, called [redacted] I also learned that after Qualcomm purchased Nuvia, Qualcomm planned on incorporating the [redacted] core into its own SOCs called [redacted]

22. I also used the technical documentation to identify the design hierarchy of Nuvia's [redacted] core and the [redacted] I then studied the design directory for the source code produced by Qualcomm. I located the RTL code corresponding to each SOC/core that Qualcomm indicated it had produced: [redacted]

23. Under each SOC/core folder, I was able to find [redacted]

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[redacted]

24. I used the [redacted] code as the baseline. [redacted]

25. The [redacted] code is dated one day before Qualcomm completed its acquisition of Nuvia. Thus, I understand that [redacted] I compared the [redacted] code against all of the other, subsequent versions of code produced by Qualcomm using a tool called Beyond Compare, which was installed on the source code desktop. My goal was to assess whether and to what extent the [redacted] remained the same in the subsequent code.

26. I performed this quantitative analysis in two ways in the source code: (1) identifying key folders and comparing files within those folders across different SOC/core versions, and (2) identifying top-level RTL files of key building blocks and comparing each of the RTL files across different SOC/core versions. The results of both quantitative analyses are the same: [redacted]

27. It is noteworthy that I used the default skew tolerance setting in the Beyond Compare tool. With this default setting, Beyond Compare will search up to 2,000 lines above or below the current line for a matching line during text alignment. I reserve the right to conduct additional testing with a different skew tolerance in response to rebuttal arguments by Qualcomm or its experts.

2. Comparing folder contents across SOC/core versions

28. As part of my analysis, I identified important source code folders in the baseline [redacted] code. I mainly focused on the source code folders related to [redacted]

[6] [redacted]

[redacted]

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

[redacted]

29. Since I was asked to analyze source code related to the [redacted] core, there were folders on the source code desktop that I did not consider in my analysis. [redacted]

30. For the folders that I did consider, I used the folder comparison function of the Beyond Compare tool to compare the contents of the folders [redacted]

31. First, I analyzed the number of common file names within the corresponding folders and calculated the file name similarity (in %). The Beyond

Compare tool reports the number of files that do not have common names, so-called "orphan files." I calculated the number of common files names by subtracting the total number of files in the folder by the number of orphan files reported by Beyond Compare. I then calculated the file name similarity (%) as the number of common file names divided by the total number of files in the folder of SOC/core version under comparison.

32. Second, I analyzed the line similarity (in %) within all the files in the corresponding folders. I used the folder comparison function of the Beyond Compare tool to generate a statistical report (in csv format). The statistical report showed the total number of original, deleted, and changed important/unimportant lines of all the files in the corresponding folder. I then used this spreadsheet to calculate the important line similarity (in %) between [redacted] and other SOCs/cores produced by Qualcomm. For any given comparison between two files, the important line similarity (in %) is defined as the number of identical important lines divided by the total number of original important lines. As shown in the tables below, I was able to determine that [redacted]. I have also found the naming

convention of RTL code documented in a technical document, [redacted]

[redacted]	[redacted]	[redacted]		[redacted]		[redacted]	
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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3. Comparing Key RTL Files Across SOC/core Versions

33. As part of my analysis, I identified important source code files in the [redacted] code. These files are important because they are the top-level RTL code files in the important design hierarchies and key functional CPU blocks as listed in Table 1. In the table below, I identify the files and explain the specific importance of each file.

[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
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[redacted]

34. I compared these key source code files between the SOC/core version under comparison and the [redacted] code. For this analysis, I used the file comparison function of the Beyond Compare tool, which reports the number of identical lines between two selected files. I then recorded the number of identical lines and calculated the line similarity (in %), defined as the number of identical lines divided by the total number of lines in the RTL file under comparison. Thus,

for any comparison of two files, the term "line similarity" means the percentage of identical lines of code between the two files. The table below summarizes my analysis.

[redacted]	[redacted]	[redacted]		[redacted]		[redacted]	
		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]

4. **Comparing [redacted] with [redacted] code**

35. I was asked to compare the [redacted] code with the [redacted] code to determine the differences between these two versions of code. I performed this analysis using the same approach that I used to compare other SOC/core versions (§ V.B.3) except the baseline is now changed to the [redacted] code. My conclusion is that the two versions of code [redacted]

[redacted]	[redacted]	[redacted]	
		[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
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C. Qualitative Approach: Arm Features are Throughout RTL Code for All SOCs/Cores.

1. Summary of qualitative approach

36. I performed a qualitative analysis to determine what features from the Arm architecture are present in the [redacted] code and are also present in subsequent versions. To perform this analysis, I used the following methodology.

37. First, counsel for Arm identified for me the [redacted] I reviewed those technical documents along with [redacted] to identify features/instructions that appear to be specific to Arm. I then used a command-line utility, called grep, to search for and identify those specific features/instructions in the [redacted] code as a baseline. [redacted] I will provide examples in the following sections.

2. [redacted]

38. [redacted] indicates that [redacted] In the source code, I examined [redacted]

[redacted]

39. I also found [redacted]

[redacted]

40. From my sampling, I found examples of [redacted]

3. [redacted]

41. [redacted]

[7] [redacted]

[redacted]

42. Since Phoenix supports the [redacted], I was able to identify, in the RTL code, a [redacted]

43. I further confirmed that the [redacted]

8 [redacted]

[redacted]

44. [redacted]

45. I then compared [redacted]

46. It is worth mentioning that [redacted]

[redacted]

[redacted]

47. I printed reports[9] showing [redacted]

4. [redacted]

48. [redacted]

49. I first confirmed that [redacted] In addition, [redacted]

---

9 [redacted]

[redacted]

50. I used the grep command to keyword search the code. I found that [redacted]

[redacted]

[redacted]

51. I printed reports showing a comparison of [redacted]

5. [redacted]

52. [redacted]

53. I did a key word search on [redacted]

VI. CONCLUSION

54. My opinions above are based on available information to date. I reserve the right to supplement or amend my opinions in this report, and also to rebut opinions by Qualcomm's experts with which I disagree. I also reserve the right to correct any clerical errors that I discover after service of this report.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct. Executed on this 20th day of December of 2023 in Los Angeles, California.

By: Shuo-Wei Chen

Dr. Shuo-Wei (Mike) Chen

Exhibit A

Mike Shuo-Wei Chen

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Email: shuowei@gmail.com (Alt: swchen@usc.edu)
Phone: 510-517-0052

Curriculum Vitae

EDUCATION

University of California, Berkeley 2002 – 2006

- PhD in Electrical Engineering and Computer Science
- Dissertation: "High-Speed, Low-Power A/D Converter for a Low-Cost UWB Sub-sampling Radio"
- Advisor: Robert W. Brodersen

University of California, Berkeley 2000 – 2002

- Master of Science in Electrical Engineering and Computer Science
- Thesis: "Ultra Wideband Baseband Design and Implementation"

National Taiwan University 1994 – 1998

- Bachelor of Science in Electrical Engineering
- Top 1 student for upper division

ACADEMIC EXPRIENCE

- Professor, Department of Electrical Engineering, University of Southern California, 2021 – Present.
- Associate Professor, Department of Electrical Engineering, University of Southern California, 2017 – 2021.
- Colleen and Roberto Padovani Early Career Chair, USC, 2014 – 2021
- Assistant Professor, Department of Electrical Engineering, University of Southern California, 2011 – 2017.
- Graduate Student Researcher, Berkeley Wireless Research Center, Berkeley, CA, 2001 – 2006.

WORK EXPRIENCE

- Analog Senior Technical Staff, Atheros Communications, Santa Clara, CA, 2006–2010.
  -Designed RF, analog mixed-signal circuits for various wireless products

CONSULTING EXPERIENCE

- Samsung (2018-now): review their research programs ranging from communication and low power electronic systems

- BAE system (2019-2022): data converter design
- Tetramem (2022-now): AI/ML computing circuitry
- Morrison & Foerster LLP (2019-2022): Xilinx-ADI litigation
  Legal consultant, working with counselors to prepare/review legal documents, non-infringement arguments, deposition, source codes, PTAB, etc.

HONORS and AWARDS

- ISSCC 2022 Jack Kilby Award (co-recipient)
- RFIC 2022 Best Student Paper Award – First Place (co-recipient)
- IEEE Solid-State Circuit Society (SSCS) Distinguished Lecturer 2021-2023.
- DARPA Young Faculty Award (YFA), 2014.
- NSF Faculty Early Career Development (CAREER) Award, 2014.
- Analog Devices Outstanding Student Award, 2006
- UC Regents Fellowship, UC Berkeley, 2000
- Lin's Foundation Award for Top 1 engineering college student over the academic year, 1996-1997
- Presidential Awards, National Taiwan University, 1996-1998
- Member of National Mathematics Team of Taiwan, awarded with Honourable Mention in Asian Pacific Mathematics Olympiad, 1994.

KEY TECHNICAL CONTRIBUTIONS

Analog Mixed-Signal and RF circuit architectures/techniques for data converters, clock generation and PA.

- Asynchronous SAR ADC (since 2006)
- Embedded TDC scheme for Digital PLL (since 2010)
- Nonuniform sampling (NUS) ADCs and NU DSP (since 2012)
- Direct spur/pulling cancellation for Digital PLL (since 2014)
- Dual-rate hybrid DAC (since 2014)
- Sub-harmonic switching (SHS) PA (since 2018)
- Time-Approximation Filter (TAF) for Transceiver (since 2019)
- Two-Point DTC Calibration scheme for Multiplying DLL (since 2021)
- Delay-tracking pipelined SAR TDC (since 2022)

PUBLICATIONS

Conferences

1. H.-C. Cheng, S. Su, M. Palaria, Q. Zhang, C. Yang, S. Hossain, R. Bena, B. Chen, Z. Liu, J. Liu, R. Rasul, Q. Nguyen, W. Wu, **M. S.-W. Chen**, "A Memristor-Based Analog Accelerator for Solving Quadratic Programming problems," in IEEE Custom Integrated Circuits Conference (CICC), April 2023.

2. S. Su*, Q. Zhang*, and **M. S.-W. Chen**, “A 2GS/s 8.5-Bit Time-Based ADC Using a Segmented Stochastic Flash TDC,” in 2023 IEEE Custom Integrated Circuits Conference (CICC), Apr. 2023 (* equal contribution)
3. Q. Zhang, H.-C. Cheng, S. Su, and **M. S.-W. Chen**, “A Fractional-N Digital MDLL with Injection Error Scrambling and Background Third-Order DTC Delay Equalizer Achieving –67dBc Fractional Spur,” in IEEE International Solid-State Circuits Conference (ISSCC), Feb. 2023. (To appear)
4. Q. Zhang*, S. Su*, and **M. S.-W. Chen**, “A Cost-Efficient Fully Synthesizable Stochastic Time-to-Digital Converter Design Based on Integral Nonlinearity Scrambling,” in 2022 59th ACM/EDAC/IEEE Design Automation Conference (DAC), July 2022. (*contributed equally to this work)
5. C. Yang, S. Su and **Mike Chen**, “A Millimeter-Wave Mixer-First Receiver with Non-Uniform Time-Approximation Filter Achieving >45-dB Blocker Rejection,” in IEEE Radio Frequency Integrated Circuits Symposium (RFIC), June 2022. (Best Student Paper Award – First Place)
6. S. Su, and **M. S.-W. Chen**, “High-Speed Digital-to-Analog Converter Design Towards High Dynamic Range,” (invited paper) *IEEE Custom Integrated Circuits Conference (CICC), Apr. 2022.*
7. J. Liu, M. Hassanpourghadi, and **M. S.-W. Chen**, “A 10GS/s 8b 25fJ/c-s 2850um2 Two-Step Time-domain ADC Using Delay-Tracking Pipelined-SAR TDC with 500fs Time Step in 14nm CMOS Technology“, *IEEE International Solid-State Circuits Conference (ISSCC)*, Feb. 2022.
8. S. Su, Q. Zhang, M. Hassanpourghadi, J. Liu, R.A. Rasul, and **M. S.-W. Chen**, “Analog/Mixed-Signal Circuit Synthesis Enabled by the Advancements of Circuit Architectures and Machine Learning Algorithms,” (invited paper) *Asia and South Pacific Design Automation Conference (ASP-DAC)*, Jan. 2022.
9. S. Su, Q. Zhang, J. Liu, M. Hassanpourghadi, R.A. Rasul, and **M. S.-W. Chen**, “TAFA: Design Automation of Analog Mixed-Signal FIR Filters Using Time Approximation Architecture,” *Asia and South Pacific Design Automation Conference (ASP-DAC)*, Jan. 2022.
10. J. Liu, S. Su, M. Madhusudan, M. HHassanpourghadi, S. Saunders, Q. Zhang, R. Rasul, Y. Li, J. Hu, A. Kumar, S. S. Sapatnekar, R. Harjani, A. Levi, S. Gupta and **M. S.-W. Chen**, “From Specification to Silicon: Towards Analog/Mixed-Signal Design Automation using Surrogate NN Models with Transfer Learning“, *IEEE/ACM International Conference on Computer-Aided Design (ICCAD)*, November 2021.
11. M. Hassanpourghadi, S. Su, R.A. Rasul, J. Liu, Q. Zhang, and **M. S.-W. Chen**, “Circuit Connectivity Inspired Neural Network for Analog Mixed-Signal Functional Modeling,” *58th ACM/EDAC/IEEE Design Automation Conference (DAC)*, Dec. 2021.(to appear)
12. R.A. Rasul, and **M. S.-W. Chen**, “A 128×128 SRAM Macro with Embedded Matrix-Vector Multiplication Exploiting Passive Gain via MOS Capacitor for Machine Learning Application,” *IEEE Custom Integrated Circuits Conference (CICC),* Apr. 2021.
13. A. Zhang, M. Ayesh, S. Mahapatra, and **M. S.-W. Chen**, “A 24-28 GHz Concurrent Harmonic and Subharmonic Tuning Class E/F2,2/3 Subharmonic Switching Power Amplifier Achieving Peak/PBO Efficiency Enhancement,” *IEEE Custom Integrated Circuits Conference (CICC), Apr. 2021*.

14. Q. Zhang, S. Su, C.-R. Ho, and **M. S.-W. Chen**, "A Fractional-N Digital MDLL with Background Two-Point DTC Calibration Achieving -60dBc Fractional Spur," *IEEE International Solid-State Circuits Conference (ISSCC),* Feb. 2021.
15. A. Zhang, C. Yang, M. Ayesh, and **M. S.-W. Chen**, "A 5-6 GHz Current-Mode Subharmonic Switching Digital Power Amplifier for Enhancing Power Back-off Efficiency," *IEEE International Solid-State Circuits Conference (ISSCC)*, Feb. 2021.
16. Q. Zhang, S. Su, J. Liu and **M. S.-W. Chen**, "CEPA: CNN-based Early Performance Assertion Scheme for Analog and Mixed-Signal Circuit Simulation," in *2020 IEEE/ACM International Conference on Computer-Aided Design (ICCAD),* November 2020.
17. J. Liu, M. Hassanpourghadi, Q. Zhang, S. Su and **M.S.-W. Chen**, "Transfer Learning with Bayesian Optimization-Aided Sampling for Efficient AMS Circuit Modeling," in *2020 IEEE/ACM International Conference on Computer-Aided Design (ICCAD),* November 2020.
18. C. Yang, M. Ayesh, A Zhang, T.F. Wu, **M. S.-W. Chen**, "A 29-mW 26.88-GHz Non-Uniform Sub-Sampling Receiver Front-End Enabling Spectral Alias Spreading, " *IEEE Radio Frequency Integrated Circuits Symposium (RFIC)*, June, 2020.
19. S. Su and **M. S.-W. Chen**, "A SAW-Less Direct-Digital RF Modulator with Tri-Level Time-Approximation Filter and Reconfigurable Dual-Band Delta-Sigma Modulation," *IEEE International Solid-State Circuits Conference (ISSCC),* Feb. 2020.
20. T.-F. Wu and **M. S.-W. Chen**, "A 40MHz-BW 76.2dB/78.0dB SNDR/DR noise-shaping nonuniform sampling ADC with single phase-domain level crossing and embedded nonuniform digital signal processor in 28nm CMOS," *IEEE International Solid-State Circuits Conference (ISSCC)*, Feb. 2020.
21. S. Su and **M. S-W Chen** , "A 1–5GHz Direct-Digital RF Modulator with an Embedded Time-Approximation Filter Achieving -43dB EVM at 1024 QAM," *IEEE Symposia on VLSI Technology and Circuits (VLSIC),* June 2019.
22. J.W. Nam, **M.S-W Chen**, "A 12.8-Gbaud ADC-based NRZ/PAM4 Receiver with Embedded Tunable IIR Equalization Filter Achieving 2.43-pJ/b in 65nm CMOS," *IEEE Custom Integrated Circuits Conference (CICC)*, April 2019.
23. M. Hassanpourghadi, **M.S-W Chen**, "A 2-way 7.3-bit 10 GS/s Time-based Folding ADC with Passive Pulse-Shrinking Cells," *IEEE Custom Integrated Circuits Conference (CICC)*, April 2019.
24. A. Zhang and **M. S-W Chen**, "A Watt-Level Phase-Interleaved Multi-Subharmonic Switching Digital Power Amplifier Achieving 31.4% Average Drain Efficiency," *IEEE International Solid-State Circuits Conference (ISSCC)*, Feb. 2019.
25. A. Zhang, **M. S-W Chen**, "A Sub-Harmonic Switching Digital Power Amplifier with Hybrid Class-G Operation for Enhancing Power Back-off Efficiency," *IEEE Symposia on VLSI Technology and Circuits (VLSIC),* 2018.
26. T.F. Wu, **M. S-W Chen**, "A 200MHz-BW 0.13mm2 62dB-DR VCO-Based Non-Uniform Sampling ADC with Phase-Domain Level Crossing in 65nm CMOS," *IEEE Custom Integrated Circuits Conference (CICC),* 2018.

27. S. Su and **M. S-W Chen**, "A 16-bit 12GS/s Single/Dual-Rate DAC with Successive Bandpass Delta-Sigma Modulator Achieving <-67dBc IM3 within DC to 6GHz Tunable Passbands," *IEEE International Solid-State Circuits Conference (ISSCC)*, Feb. 2018.
28. C.R. Ho, **M. S-W Chen**, "A digital frequency synthesizer with dither-assisted pulling mitigation for simultaneous DCO and reference path coupling," *IEEE International Solid-State Circuits Conference (ISSCC)*, Feb. 2018.
29. C.R. Ho, **M. S-W Chen**, "A fractional-N digital PLL with background dither noise cancellation loop achieving <-62.5dBc worst-case near-carrier fractional spur in 65nm CMOS," *IEEE International Solid-State Circuits Conference (ISSCC)*, Feb. 2018.
30. R. Rasul, P. Teimouri, and **M. S-W Chen**, "A Time Multiplexed Network Architecture for Large-Scale Neuromorphic Computing," IEEE MWSCAS, August 2017.
31. C.R. Ho, **M. S-W Chen**, "Interference-Induced DCO Spur Mitigation for Digital Phase Locked Loop in 65-nm CMOS," *IEEE European Solid-State Circuits Conference (ESSCIRC),* Sep. 2016.
32. J.W. Nam, M. Hassanpourghadi, A. Zhang, **M.S-W Chen**, "A 12-bit 1.6 GS/s Interleaved SAR ADC with Dual Reference Shifting and Interpolation Achieving 17.8 fJ/conv-step in 65nm CMOS," *IEEE Symposia on VLSI Technology and Circuits (VLSIC),* June 2016.
33. C.R. Ho, **M. S-W Chen**, "A Digital PLL with Feedforward Multi-Tone Spur Cancelation Loop Achieving <-73dBc Fractional Spur and <-110dBc Reference Spur in 65nm CMOS," *IEEE International Solid-State Circuits Conference (ISSCC)*, Feb. 2016.
34. S. Su, **M. S-W. Chen**, "A 12b 2GS/s Dual-Rate Hybrid DAC with Pulsed Timing-Error Pre-Distortion and In-Band Noise Cancellation Achieving >74dBc SFDR up to 1GHz in 65nm CMOS," *IEEE International Solid-State Circuits Conference (ISSCC)*, Feb. 2016.
35. T.F. Wu, C.R. Ho, **M. S.-W. Chen**, "A Flash-Based Non-Uniform Sampling ADC Enabling Digital Anti-Aliasing Filter in 65nm CMOS," *IEEE Custom Integrated Circuits Conference (CICC)*, Sep 2015.
36. S. Su, T. Tsai, P. Sharma, **M. S.-W. Chen**, "A 12-bit Hybrid DAC with 8GS/s Unrolled Pipeline Delta-Sigma Modulator achieving >75dB SFDR over 500MHz in 65nm CMOS," *IEEE Symposia on VLSI Technology and Circuits (VLSIC),* June 2014.
37. C.R. Ho, **M. S.-W. Chen**, "A Fractional-N DPLL with Adaptive Spur Cancellation and Calibration-Free Injection-Locked TDC in 65nm CMOS," to be presented at *IEEE Radio Frequency Integrated Circuits Symposium (RFIC)*, June, 2014.
38. J.W. Nam, D. Chiong, and **M. S.W. Chen**, "A 95-MS/s 11-bit 1.36-mW Asynchronous SAR ADC with Embedded Passive Gain in 65nm CMOS," *IEEE Custom Integrated Circuits Conference (CICC)*, Sep. 2013
39. P.K. Sharma, and **M. S.W. Chen**, "A 6b 800MS/s 3.62mW Nyquist AC-coupled VCO Based ADC in 65nm CMOS ," *IEEE Custom Integrated Circuits Conference (CICC)*, Sep. 2013

40. **M. S.W. Chen**, "Trend of High-Speed SAR ADC towards RF Sampling," *10th International Conference on Sampling Theory & Applications (SampTA)* (Invited), July. 2013.
41. D. Hand, and **M. S.W. Chen**, "A Non-Uniform Sampling ADC Architecture with Embedded Alias-Free Asynchronous Filter," Global Telecommunications Conference (GLOBECOM), Dec. 2012.
42. **M. S.W. Chen**, "Overhead Minimization Techniques for Digital Phase-Locked Loop Frequency Synthesizer, " IEEE MWSCAS (Invited Session), Aug. 2012.
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47. **M. S.-W. Chen** and R. W. Brodersen, "Digital Complex Signal Processing Techniques for Impulse Radio," *Global Telecommunications Conference (GLOBECOM)*, Nov. 2006.
48. **M. S.-W. Chen** and R. W. Brodersen, "Implementation Considerations for a Sub-sampling Impulse Radio," *IEEE International Conference on Ultra-Wideband (ICUWB)*, Sep. 2006.
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50. D. Cabric, **M. S.-W. Chen**, D. Sobel, J. Yang, and R. Brodersen, "Future Wireless Systems: UWB, 60 GHz, and Cognitive Radios," (Invited paper) at *Custom Integrated Circuits Conference (CICC)*, Sep. 2005
51. **M. S.-W. Chen**, R. W. Brodersen, "The Impact of a Wideband Channel on UWB System Design," *Military Communication Conference (MILCOM)*, Nov. 2004.
52. **M. S.-W. Chen**, R. W. Brodersen, "A Subsampling UWB Radio Architecture by Analytic Signaling," *International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, May 2004.
53. I. O'Donnell, **M. S.-W. Chen**, S. Wang, R. W. Brodersen, "An Integrated, Low-Power, Ultra-Wideband Transceiver Architecture for Low-Rate, Indoor Wireless Systems," *IEEE CAS Workshop on Wireless Communications and Networking*, Sep. 2002.

Journals

1. C. Yang, S. Su, and M. S.-W. Chen, "Millimeter-Wave Receiver with Non-Uniform Time-Approximation Filter," IEEE J. Solid-State Circuits, 2023 (in press).
2. J. Liu, M. Hassanpourghadi, and M. S.-W. Chen, "A 10-GS/s 8-bit 2850-µm2 Two-Step Time-Domain ADC With Speed and Efficiency Enhanced by the Delay-Tracking Pipelined-SAR TDC," IEEE J. Solid-State Circuits, 2022.
3. S. Su and **M. S.-W. Chen**, "SAW-Less Direct RF Transmitter with Multi-Mode Noise Shaping and Tri-Level Time-Approximation Filter," IEEE J. Solid-State Circuits, Mar. 2022.
4. Q. Zhang, S. Su, C.-R. Ho, and **M. S.-W. Chen**, "A Fractional-N Digital MDLL With Background Two-Point DTC Calibration," (Invited) *IEEE J. Solid-State Circuits* (JSSC), Jan. 2022.
5. M. Hassanpourghadi, R. A. Rasul, and **M. S. W. Chen**, "A Module-Linking Graph Assisted Hybrid Optimization Framework for Custom Analog and Mixed-Signal Circuit Parameter Synthesis" ACM Transactions on Design Automation of Electronic Systems, June 2021.
6. X. Yan, J. Ma, T. Wu, A. Zhang, J. -B. Wu, M. Chin, Z. Zhang, M. Dubey, W. Wu, **M. S.-W. Chen**, J. Guo, H. Wang "Reconfigurable Stochastic Neurons Based on Tin Oxide/MoS2 Hetero-memristors for Simulated Annealing and the Boltzmann Machine" Nature Communications, 12, Article number: 5710 (2021)
7. S. Su, **M. S.-W. Chen**, "A Time-approximation Filter for Direct RF Transmitter," *IEEE J. Solid-State Circuits* (JSSC) 2021.
8. J.W. Nam, **M. S.-W. Chen**, "A 12.8-Gbaud ADC-based Wireline Receiver with Embedded IIR Equalizer," (Invited) *IEEE J. Solid-State Circuits* (JSSC), Mar. 2020.
9. A. Zhang, **M. S-W. Chen**, "A Watt-Level Phase-Interleaved Multi-Subharmonic Switching Digital Power Amplifier," (Invited) *IEEE J. Solid-State Circuits* (JSSC) Nov., 2019.
10. A. Zhang, **M. S-W. Chen**, "A Subharmonic Switching Digital Power Amplifier for Power Back-Off Efficiency Enhancement," (Invited) *IEEE J. Solid-State Circuits* (JSSC) Feb., 2019.
11. T.F. Wu, **M. S.-W. Chen**, "A VCO-Based Nonuniform Sampling ADC with Phase-Domain Level Crossing," (Invited) *IEEE J. Solid-State Circuits* (JSSC) Mar., 2019.
12. S. Su, **M. S.-W. Chen**, "A 16-bit 12GS/s Single/Dual-Rate DAC with a Successive Bandpass Delta-Sigma Modulator Achieving <-67dBc IM3 within DC to 6GHz Tunable Passbands," (Invited) *IEEE J. Solid-State Circuits* (JSSC) Dec., 2018.
13. T.F. Wu, **M. S-W. Chen**, "A Subranging-Based Nonuniform Sampling ADC With Sampling Event Filtering," *IEEE Solid-State Circuits Letters* (SSC-L) April, 2018.
14. J.W. Nam, M. Hassanpourghadi, A. Zhang, **M.S-W Chen**, "A 12-bit 1.6/3.2/6.4 GS/s 4 b/cycle Time-interleaved SAR ADC with Dual Reference Shifting and Interpolation," *IEEE J. Solid-State Circuits* (JSSC), June, 2018.
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16. M. Hassanpourghadi, P.K. Sharma, and **M. S.-W. Chen**, "A 6-bit Nyquist AC-coupled VCO Based ADC at 800MS/s," IEEE Transactions on Circuits and Systems (TCAS-I) 2017.
17. C.R. Ho, **M. S.-W. Chen**, "A Digital PLL with Feedforward Multi-Tone Spur Cancelation Loop Achieving <-73dBc Fractional Spur and <-110dBc Reference Spur in 65nm CMOS," (Invited) accepted for *IEEE J. Solid-State Circuits* (JSSC) Dec., 2016.
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20. T.F. Wu, S. Dey, **M. S.-W. Chen**, "A Non-Uniform Sampling ADC Architecture with Reconfigurable Digital Anti-aliasing Filter," accepted by IEEE Transactions on Circuits and Systems (TCAS-I) 2016
21. C.R. Ho, **M. S.-W. Chen**, "A Fractional-N DPLL with Calibration-free Multi-phase Injection-locked TDC and Adaptive Single-tone Spur Cancellation Scheme," accepted by IEEE Transactions on Circuits and Systems (TCAS-I) 2016
22. S. Su, T. Tsai, P. Sharma, **M. S.W. Chen**, "A 12-bit 1GS/s Dual-Rate Hybrid DAC with an 8GS/s Unrolled Pipeline Delta-Sigma Modulator Achieving >75dB SFDR over the Nyquist Band," (Invited) *IEEE J. Solid-State Circuits,* April, 2015.
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24. **M.S.W. Chen**, D. Su, S. Mehta, "A Calibration-Free 800MHz Fractional-N Digital PLL with Embedded TDC," (Invited) *IEEE Journal of Solid-State Circuits*, Dec. 2010.
25. Zargari, M.; Nathawad, L.Y.; Samavati, H.; Mehta, S.S.; Kheirkhahi, A.; Chen, P.; Gong, K.; Vakili-Amini, B.; Hwang, J.A.; **Chen, S.-W.M.**; Terrovitis, M.; Kaczynski, B.J.; Limotyrakis, S.; Mack, M.P.; Gan, H.; MeeLan Lee; Chang, R.T.; Dogan, H.; Abdollahi-Alibeik, S.; Baytekin, B.; Onodera, K.; Mendis, S.; Chang, A.; Rajavi, Y.; Jen, S.H.-M.; Su, D.K.; Wooley, B.A., "A Dual-Band CMOS MIMO Radio SoC for IEEE 802.11n Wireless LAN," *IEEE J. Solid-State Circuits*, Dec. 2008.
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Magazine

1. **M. S.-W. Chen**, "Trend and New Opportunities in Digital PLL Design", (Invited) IEEE Solid State Circuit Magazine, 2020 winter issue.
2. C.R. Ho, **M. S-W. Chen**, "Clock Generation in the future with Digital Signal Processing Technique for Mitigating Spur and Interference," IEEE Microwave Magazine 2019.
3. Sankaran, S.G.; Zargari, M.; Nathawad, L.Y.; Samavati, H.; Mehta, S.S.; Kheirkhahi, A.; Chen, P.; Ke Gong; Vakili-Amini, B.; Hwang, J.; **Chen, S.-W.M.;** Terrovitis, M.; Kaczynski, B.J.; Limotyrakis, S.; Mack, M.P.; Gan, H.; Lee, M.; Chang, R.T.; Dogan, H.; Abdollahi-Alibeik, S.; Baytekin, B.; Onodera, K.; Mendis, S.; Chang, A.; Rajavi, Y.; Jen, S.H.-M.; Su, D.K.; Wooley, B., "Design and implementation of a CMOS 802.11n soc –[integrated circuits for communications]," *Communications Magazine*, April 2009.
4. D. Cabric, I. O'Donnell, **M. S.-W. Chen**, and R.W. Brodersen, "Spectrum Sharing Radios," (Invited) *IEEE Circuits and Systems Magazine*, 2006.

Book Chapter

1. C.R. Ho, **M. S.-W. Chen**, "Fractional-N spur reduction techniques for DPLL," *Phase-Locked Frequency Generation and Clocking: Architectures and Circuits for Modern Wireless and Wireline Systems*, IET 2019 (under preparation).
2. **M. S.-W. Chen**, "Challenges and Emerging Trend of DSP Enabled Frequency Synthesizer," Digitally-Assisted Analog *and Analog-Assisted Digital IC Design.* Chapter4, 2015, Cambridge University Press.
3. **M. S.-W. Chen**, "Energy-Efficient ADC Topology Enabled with Asynchronous Techniques," *Circuits for Nanoscale: Communications, Imaging, and Sensing.* Chapter14, Sep. 2008.

Patent

1. **M.S.W. Chen**, C.R. Ho, "Adaptive spur cancellation techniques and multi-phase injection locked TDC for digital phase locked loop circuit," US patent #9941891, 2018.
2. **M. S.W. Chen**, "Non-uniform Sampling Analog to Digital Converter (ADC) Architecture with Digital Reconfigurable Anti-Aliasing Filter," filed for provisional patent application, No. 61/911,261, Dec., 2013.
3. **M. S.W. Chen**, D. Su, "Fractional and Integer PLL Architectures," US patent #8289086, 2012.

INVITED TALKS/TUTORIALS/WORKSHOPS

1. ITRI, Taiwan, "New Opportunities in Mixed-Signal ICs", June, 2011.
2. UMC, Taiwan, "New Opportunities in Mixed-Signal ICs", June, 2011.
3. HRL Laboratories, LLC: "Enhancing A-to-D Conversion Efficiency". July 2nd, 2012

4. “Analog-to-Digital Interface: A Time Approach” 2013 CMOS Emerging Technologies Research Symposium, Whistler, July 2013.
5. “Path towards High-Speed High-Resolution Data Converters with Diminishing Cost”, Sep. 2013, Broadcom.
6. “Analog-Digital Interface Research, really?” Sep. 2013, Qualcomm-Atheros.
7. “Re-shape Future Mixed-Signal IC Design” Oct. 2013. Qualcomm.
8. “Path towards High-Speed High-Resolution Data Converters with Diminishing Cost”, Nov. 2013, UT Dallas.
9. “Path towards High-Speed High-Resolution Data Converters with Diminishing Cost”, Nov. 2013, Texas Instrument.
10. “Power efficient ADC Topologies towards RF Sampling” 2014 RFIC Tutorial.
11. “Path Towards Direct RF Synthesis: A Hybrid Digital-to-Analog Converter Architecture” 2014 IEEE MWSCAS Conference, Distinguished Speaker Series.
12. “Asynchronous SAR ADC: Past, Present and Beyond” 2014 IEEE MWSCAS Conference Tutorial
13. “Exploring Limits of Mixed-Signal ICs” Sep. 2014, MaxLinear Corp.
14. “Rethinking Analog-Digital Interface Circuit Architectures” Oct. 2014, IC Seminar, Columbia University, NY.
15. “Rethinking Analog-Digital Interface Circuit Architectures” Mar. 2015, IC Seminar, UC Berkeley, CA.
16. “Rethinking Analog-Digital Interface Circuit Architectures” Dec. 2015, IC Seminar, National Taiwan University(NTU)/IEEE Chapter, Taipei, Taiwan.
17. “Rethinking Analog-Digital Interface Circuit Architectures” Feb. 2016, IC Seminar, UT Austin, Texas.
18. “Asynchronous SAR ADC: Past, Present and Beyond”, Feb. 2016, EE department Colloquium, UT Austin/IEEE Chapter.
19. “Rethinking Analog-Digital Interface Circuit Architectures” Feb. 2016, IC Seminar, University of Michigan, Ann Arbor.
20. “Rethinking Analog-Digital Boundary from Circuit to System Level towards Reconfigurability of Everything” Mar. 2016, SystemX Seminar, Stanford
21. “Rethinking Analog-Digital Interface Circuit Architectures” April. 2016, EE department Colloquium. Carnegie Mellon University (CMU).
22. “Rethinking Analog-Digital Interface Circuit Architectures” April. 2016, IC Seminar, University of California, Los Angeles (UCLA).
23. “IC Research overview,” TSMC, 2017
24. “IC Research overview,” Intel Lab, 2017
25. “IC Research overview,” InPhi, 2017
26. “Advancing Low-Power High-Speed Analog-to-Digital Converters: An Asynchronous Design Approach”, VLSI DAT tutorial, 2017
27. “Generic spur cancellation for digital PLL,” Qualcomm 2017
28. “Evolutions of SAR ADC: from High Resolution to High Speed Regime,” IEEE CICC 2018 tutorial.
29. “Emerging Opportunities in Analog Mixed-Signal Circuit Design Automation,” ACM/IEEE ICCAD 2018 workshop.
30. “Analog-to-Digital Converter Architecture Opportunities in Emerging Wireless Systems,” RFIC 2018 workshop

31. "How can hardware designers reclaim the spotlight?" moderator/co-organizer of ISSCC 2019 evening panel.
32. "Fundamentals of Analog-to-digital conversion," 2-day tutorial in Shanghai, China 2019.
33. "Digital Fractional-N Phase Locked Loop Design," tutorial, ISSCC Feb 2020
34. "Digital Fractional-N Phase Locked Loop Design," ISSCCedu Feb 2020
35. "Low Spur PLL architectures," MEAD tutorial in EPFL, 2021 (to appear)
36. "Low Spur PLL architectures and techniques, " IEEE CICC 2020
37. "New Opportunities in Nonuniform Sampling," IEEE SSCS Webinar Oct 2020.
38. "High-Performance Digital-to-Analog Converter Design: A Path towards Digital Transmitter," ISESD Keynote June 2021
39. "ADC Evolution via Architectural Rethinking: from Asynchronous SAR to Non-uniform Sampling ADC," IEEE SSCS Tainan Chapter, Oct 2021
40. "High-Performance Digital-to-Analog Converter Design: A Path towards Digital Transmitter," IEEE SSCS Atlanta Chapter, Nov. 2021
41. "Asynchronous SAR ADC: Past, Present and Beyond," IEEE Southern Alberta Chapter, Nov. 2021
42. "Non-Uniform Sampling Data Converters: A Journey to Uncharted Circuits and Systems" IEEE VLSI-DAT April 2022
43. "Asynchronous SAR ADC: Past, Present and Beyond," IEEE Swiss Chapter, May 2022
44. "New Opportunities in Nonuniform Sampling," IEEE Penang Chapter, July 2022
45. "Trend in Digital PLL Design and New Opportunities in Spur Cancellation," IEEE Southern Alberta Chapter, Sep. 2022
46. "High-Performance Digital-to-Analog Converter Design: A Path towards Digital Transmitter," IEEE Egypt Chapter Nov. 2022
47. "New Opportunities in Nonuniform Sampling," IEEE Taipei Chapter, Dec. 2022
48. "Trend in Digital PLL Design and New Opportunities in Spur Cancellation," IEEE Tainan Chapter, Dec. 2022

PROFESSIONAL SERVICES

Review Panel:

1. IEEE SSCS James D. Meindl Innovators Award
2. NSF Panelist
3. Samsung Research

Journal article review:

1. IEEE Journal of Solid-State Circuits
2. IEEE Solid-State Circuits Letters (SSC-L)
3. IEEE Transactions on Signal Processing
4. IEEE Transactions on Communications
5. IEEE Transactions on Circuits and Systems I
6. IEEE Transactions on Circuits and Systems II
7. IEEE Transactions on Vehicular Technology
8. IEEE Communications Letters

9. Journal of VLSI Signal Processing Systems

USC Department Services:

1. Munishian Series Committee
2. EFC
3. EE Festival reviewer

Conference TPC:

IEEE European Conference on Solid-State Circuits (ESSCIRC) (2022- present)
IEEE International Solid State Circuits Conference (ISSCC) (2018 - present)
IEEE Symposium on VLSI Circuits (VLSIC) (2017 - 2020)
IEEE Custom Integrated Circuits Conference (CICC) (2015 - 2019)
IEEE GlobalSIP (2014)

Organized/Participated Panel/Forum/Workshops for SSCS:

1. Forum: "Emerging Design Techniques for Data Converters" served as organizer at CICC 2017
2. Panel: "What can/should Circuit Designers do to Ride on the Wave of Machine Learning?" served as co-organizer and moderator at CICC 2018
3. Panel: "How can hardware designers reclaim the spotlight?" served as co-organizer and moderator at ISSCC 2019
4. Panel: "Favorite circuit design and testing mistakes of starting engineers?" served as co-organizer at ISSCC 2021
5. VLSI Symposia Mentoring Event June 2021
6. Panel: "How to choose career path, academia, industry, startups?" served as panelist at CICC 2022 (to appear)
7. Panel: "Open Source Systems, Circuits, and Design: Is It the Future?" served as panelist at CICC 2022 (to appear)

Associate Editor:

SSC-L, TCAS-II

Society Membership:

Senior Member of IEEE

CURRENT, PRIOR, AND PENDING RESEARCH GRANTS

Current Research Grants

Proposal Title: SpecEES: Switched-Capacitor Radiofrequency Signal Processing for Spectrally-Agile Low-Energy Wireless Transceivers
Source of Support: NSF: ECCS-1824442
Project Location: USC PI: Hossein Hashemi, Co-PI: Mike Chen
Total Award Amount: $675,000 (Chen's share: $313,991)
Starting Date: 09/01/2018 Ending Date: 08/31/2023

Proposal Title: Bio-inspired hybrid computing platform for micro-unmanned vehicles
Source of Support: IARPA: 2021-21090200005
Project Location: USC PI: Wei Wu, Co-PIs: Mike Chen, Quan Nguyen
Total Award Amount: $3,000,000 (Chen's share: $1,100,000)
Starting Date: 09/27/2021 Ending Date: 10/26/2023

Proposal Title: High-Speed Multi-GS/s Time-based ADC
Source of Support: MediaTek Inc.
Project Location: USC PI: Mike Chen
Total Award Amount: $160,000
Starting Date: 01/01/2022 Ending Date: 01/01/2024

Proposal Title: Center for Ubiquitous Connectivity (CUbiC)
Source of Support: Columbia University (Prime: SRC): 2023-JU-3132
Project Location: USC PI: Mike Chen
Total Award Amount: $1,250,000
Starting Date: 01/01/2023 Ending Date: 12/31/2027

Proposal Title: High-Speed DAC with High Output Power and Linearity
Source of Support: University of Texas at Dallas (Prime: SRC): 2023-AM-3160
Project Location: USC PI: Mike Chen
Total Award Amount: $270,000
Starting Date: 01/01/2023 Ending Date: 12/31/2025

Proposal Title: Machine-Learning Based Analog Mixed-signal Design Tool
Source of Support: University of Texas at Dallas (Prime: SRC): 2023-AM-3160
Project Location: USC PI: Mike Chen, Co-PIs: Sandeep Gupta, Anthony Levi
Total Award Amount: $285,000 (Chen's share: $259,568)
Starting Date: 01/01/2023 Ending Date: 12/31/2025

Proposal Title: Design Automation of Low Phase Noise PLL
Source of Support: University of Texas at Dallas (Prime: SRC): 2023-AM-3160
Project Location: USC PI: Mike Chen, Co-PIs: Sandeep Gupta, Anthony Levi
Total Award Amount: $270,000 (Chen's share: $244,568)
Starting Date: 01/01/2023 Ending Date: 12/31/2025

Prior Research Grants

Proposal Title: Techniques Estimating Reliability in COTS ICs (Phase 1)
Source of Support: DARPA: HR0011-11-C-0067 CLIN0001
Project Location: USC PI: Michael Fritze, Co-PI: Mike Chen
Total Award Amount: $2,428,225 (Chen's share: $299,153)

Starting Date: 07/21/2011 Ending Date: 03/07/2013

Proposal Title: Techniques Estimating Reliability in COTS ICs (Phase 2)
Source of Support: DARPA: HR0011-11-C-0067 CLIN0002
Project Location: USC PI: Michael Fritze, Co-PI: Mike Chen
Total Award Amount: $1,787,093 (Chen's share: $47,783)
Starting Date: 02/20/2013 Ending Date: 09/20/2014

Proposal Title: Silicon-Based Monolithic Digital RF Memory
Source of Support: ONR: N00014-11-1-0819
Project Location: USC PI: Hossein Hashemi, Co-PI: Mike Chen
Total Award Amount: $1,200,000 (Chen's share: $600,000)
Starting Date: 08/01/2011 Ending Date: 09/30/2015

Proposal Title: Multi-Tier Reconfigurable Transceivers for Hand-Portable Radio and Micro Base Stations
Source of Support: DARPA: HR0011-12-C-0094
Project Location: USC PI: Hossein Hashemi, Co-PI: Mike Chen
Total Award Amount: $3,257,252 (Chen's share: $400,000)
Starting Date: 08/20/2012 Ending Date: 07/15/2017

Proposal Title: Computational Leverage Against Surveillance Systems (CLASS)
Source of Support: Itt Exelis (Prime: DARPA): 473685J
Project Location: USC PI: Mike Chen
Total Award Amount: $287,125
Starting Date: 06/12/2013 Ending Date: 12/22/2014

Proposal Title: Design of Integrated Circuit for Intravascular Radial Arrays
Source of Support: Texas Instruments Inc.
Project Location: PI: K. Kirk Shung, Co-PI: Mike Chen
Total Award Amount: $150,000 (Chen's share: $29,332)
Starting Date: 02/01/2014 Ending Date: 01/31/2015

Proposal Title: Dual-Channel UWB Impulse-Based Interconnect Towards Large-Scale Plastic Neural Network
Source of Support: DARPA YFA (SPANAVWAR): N66001-14-1-4049
Project Location: USC PI: Mike Chen
Total Award Amount: $500,000
Starting Date: 09/04/2014 Ending Date: 09/03/2017

Proposal Title: Computational Leverage Against Surveillance Systems (CLASS) Phase 2

Source of Support: NexGen (Prime: DARPA): 004897-00001
Project Location: USC PI: Mike Chen
Total Award Amount: $450,000
Starting Date: 10/01/2014 Ending Date: 03/31/2016

Proposal Title: R2 Transceiver Integration
Source of Support: Google: R2-USC-01
Project Location: USC PI: Mike Chen
Total Award Amount: $800,000
Starting Date: 04/23/2015 Ending Date: 03/31/2016

Proposal Title: R2 2.0 Transceiver Integration - 2016 (Statement of Work #R2-USC-02)
Source of Support: Google: 349783
Project Location: USC PI: Mike Chen
Total Award Amount: $600,000
Starting Date: 04/01/2016 Ending Date: 12/31/2016

Proposal Title: Wideband High-Dynamic Arbitrary Signal Generator for Electronic Warfare Integrated Systems Research
Source of Support: ONR (DURIP): N00014-15-1-2817
Project Location: USC PI: Hossein Hashemi, Co-PI: Mike Chen
Total Award Amount: $189,500
Starting Date: 09/29/2015 Ending Date: 09/27/2017

Proposal Title: Calibration and Characterization of High-Speed Data Converter and Clock Generator
Source of Support: ONR: N00014-15-1-2864
Project Location: USC PI: Hossein Hashemi, Co-PI: Mike Chen
Total Award Amount: $150,000 (Chen's share: $100,383)
Starting Date: 09/30/2015 Ending Date: 06/30/2016

Proposal Title: Support for April 2017 Connectivity CDF
Source of Support: Airbus: SWLA00034
Project Location: USC PI: Mike Chen
Total Award Amount: $20,000
Starting Date: 04/26/2017 Ending Date: 05/31/2017

Proposal Title: CAREER: Asynchronous Analog-to-Digital Converters with Non-Uniform Discrete-Time Signal Processing
Source of Support: NSF: ECCS-1351956
Project Location: USC PI: Mike Chen
Total Award Amount: $400,000

Starting Date: 02/15/2014 Ending Date: 01/31/2020

Proposal Title: EARS: Enabling Opportunistic Environmental Monitoring with Non-Uniform Sampling and Processing Circuits
Source of Support: NSF: ECCS-1643004
Project Location: USC PI: Mike Chen, Co-PIs: Mahta Moghaddam, Keith Chugg
Total Award Amount: $899,998 (Chen's share: $300,000)
Starting Date: 10/01/2016 Ending Date: 09/30/2021

Proposal Title: Automated Analog Mixed-Signals (AMS) Intellectual Property Generator for Complementary Metal Oxide Semiconductor (CMOS) Technologies
Source of Support: DARPA (account managed by AFRL): FA8650-18-2-7853
Project Location: USC PI: Anthony Levi, Co-PIs: Mike Chen, Sandeep Gupta, Wes Hanford
Total Award Amount: $6,028,731 (Chen's share: $ $1,930,468)
Starting Date: 06/25/2018 Ending Date: 12/30/2022

Proposal Title: Discrete-time mm-wave Processors for Scalable Digital Arrays
Source of Support: DARPA (account managed by AFRL): FA8650-19-1-7996
Project Location: USC PI: Hossein Hashemi, Co-PI: Mike Chen
Total Award Amount: $1,200,000 (Chen's share: $600,000)
Starting Date: 10/09/2018 Ending Date: 01/10/2023

Pending Research Grants

Proposal Title: CMOS Integrated Warm Electronics for Large Format Far Infrared Detectors
Source of Support: Jet Propulsion Laboratory (Prime: NASA)
Project Location: USC PI: Mike Chen
Total Award Amount: $393,294
Starting Date: 10/01/2023 Ending Date: 09/30/2026

Proposal Title: SHF: Medium: Transistors to Algorithm Hardware Acceleration of Boolean Satisfiability (SAT) and NP Complete Problems
Source of Support: NSF
Project Location: USC PI: Sandeep Gupta, Co-PIs: Pierluigi Nuzzo, Mike Chen, Tony Levi
Total Award Amount: $1,199,994 (Chen's share: $259,544)
Starting Date: 10/01/2023 Ending Date: 09/30/2026

Proposal Title: ACED Fab: 3D memristor/CMOS Hybrid Field-programmable Analog Arrays for Signal Processing from RF to Baseband
Source of Support: NSF
Project Location: USC PI: Mike Chen, Co-PIs: Joshua Yang, Qiangfei Xia

Total Award Amount: $600,000 (Chen's share: $420,000)
Starting Date: 07/01/2023 Ending Date: 06/30/2026

Proposal Title: EFRI BRAID: Efficient learning in strongly-biased memristor-based neural architectures
Source of Support: NSF
Project Location: USC PI: Bartlett Mel, Co-PIs: Joshua Yang, Mike Chen, Greg Ver Steeg
Total Award Amount: $1,996,702 (Chen's share: $94,202)
Starting Date: 08/16/2023 Ending Date: 08/15/2027

Exhibit B
List of Materials Considered

All documents cited within this report.
Qualcomm Source Code computer.

Source Code

All source code print requests submitted by Dr. Chen, including:

- QSC1ARMVQC0000001 – QSC1ARMVQC0000021
- QSC1ARMVQC0000022 – QSC1ARMVQC0000064
- QSC1ARMVQC0000065 – QSC1ARMVQC0000145
- QSC1ARMVQC0000146 – QSC1ARMVQC0000188
- QSC1ARMVQC0000189 – QSC1ARMVQC0000259
- Any print outs requested by Chen and not yet provided by Qualcomm at the time of signing this report.

Correspondences

- Correspondence dated 09/12/2023, email from J. Braly to F. Patel

Pleadings

- Arm Ltd. v. Qualcomm Inc. et al., No. 1-22-cv-001146 MN (D. Del.): ECF No. 1, Complaint, dated August 31, 2022.

Discovery

- Defendants' Response and Objections to Plaintiff's First Set of Interrogatories (Nos. 1-13), dated February 27, 2023.
- Plaintiff's Third Set of Requests for Production to Defendants (Nos. 59-122), dated July 19, 2023.

Deposition Transcripts

Singh Deposition Transcript dated September 22, 2023.
Gulati Deposition Transcript dated October 12, 2023.
Chunduru Deposition Transcript dated October 20, 2023.
Herbert Deposition Transcript dated October 25, 2023.
Trivedi Deposition Transcript dated October 25, 2023.
Abbey Deposition Transcript dated October 27, 2023.
Sharma Deposition Transcript dated October 27, 2023.
Couillard Deposition Transcript dated November 2, 2023.
Williams Deposition Transcript dated November 3, 2023.
Asghar Deposition Transcript dated November 8, 2023.

Williamson Deposition Transcript dated November 9, 2023.
Amon Deposition Transcript dated November 15, 2023.
Grisenthwaite Deposition Transcript dated November 15, 2023.
Segars Deposition Transcript dated November 16, 2023.
Roberts Deposition Transcript dated November 28, 2023.
Thompson Deposition Transcript dated November 28, 2023.
Bos Deposition Transcript dated November 29, 2023.
Shivashankar Deposition Transcript dated November 30, 2023.
Kanapathipillai Deposition Transcript dated December 1, 2023.
Werkheiser Deposition Transcript dated December 7, 2023.
Armstrong Deposition Transcript dated December 8, 2023.
Balakrishnan Deposition Transcript dated December 8, 2023
Haas Deposition Transcript dated December 12, 2023.
Sands Deposition Transcript dated December 14, 2023.

Websites

- Stephen Nellis, *Former Apple chip executives found company to take on Intel, AMD*, REUTERS, https://www.reuters.com/article/us-nuvia-tech-idUSKBN1XP19V/?taid=5dcefd5c1dd1a30001b949f0&utm_campaign=trueAnthem%3A+Trending+Content&utm_medium=trueAnthem&utm_source=twitter (last visited December 18, 2023).
- QUALCOMM, Press Release: Qualcomm to Acquire NUVIA (Jan. 21, 2021), https://www.qualcomm.com/news/releases/2021/01/qualcomm-acquire-nuvia (last visited December 18, 2023).
- QUALCOMM, Press Note: Qualcomm Completes Acquisition of NUVIA (Mar. 15, 2021), https://www.qualcomm.com/news/releases/2021/03/qualcomm-completes-acquisition-nuvia (last visited December 18, 2023).

Produced Documents

ARM_00099622 (NUVIA248705)	ARM_01324149	QCARM_0000864	QCARM_0169739
QCARM_0170271	QCARM_0181939	QCARM_0181947	QCARM_0181949
QCARM_0325086	QCARM_0325371	QCARM_0332617	QCARM_0359951
QCARM_0490031	QCARM_0490329	QCARM_2396579	QCARM_2402257
QCARM_2402586	QCARM_2412688	QCARM_2414840	QCARM_2540979
QCARM_2551809	QCARM_3041647	QCARM_3087396	QCARM_3087757
QCARM_3087992	QCARM_3088245	QCARM_3088553	QCARM_3088937
QCARM_3089361			

Exhibit 3

HIGHLY CONFIDENTIAL – ATTORNEYS' EYES ONLY

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

ARM LTD., a U.K. corporation, Plaintiff, v. QUALCOMM, INC., a Delaware corporation, QUALCOMM TECHNOLOGIES, INC., a Delaware corporation, and NUVIA, INC., a Delaware corporation Defendants.	§ § § § § § § § § § § § § § §	C.A. No. 22-1146 (MN))

EXPERT REPORT OF W. TODD SCHOETTELKOTTE
RELATING TO REMEDIES FOR DEFENDANTS' BREACH OF CONTRACT

I DECLARE UNDER PENALTY OF PERJURY THAT THE FOLLOWING IS TRUE AND CORRECT.

[signature]	12-20-23
W. TODD SCHOETTELKOTTE	EXECUTED ON

Table of Contents

I. INTRODUCTION

1. Plaintiff Arm Ltd. ("Arm" or "Plaintiff") has accused Defendants Qualcomm Inc., Qualcomm Technologies, Inc. (collectively, "Qualcomm") and Nuvia, Inc. ("Nuvia") (both collectively, "Defendants") of breaching the Nuvia Architecture License Agreement (the "Nuvia ALA").[1] More specifically, I understand Arm alleges that Nuvia was acquired by Qualcomm without Arm's consent to assignment of the Nuvia ALA, and that Nuvia therefore breached Section [redacted] of the Nuvia ALA.[2] I understand that Arm further alleges that subsequent to Arm's termination of the Nuvia ALA, Defendants continued to use [redacted],[3] [redacted], [redacted] in breach of the termination provision in Section [redacted] of the Nuvia ALA.[4] As a remedy for Defendants' breach of the Nuvia ALA, I understand that Arm seeks specific performance of the termination provisions in Section [redacted] of the Nuvia ALA, *i.e.*, [redacted].[5]

2. I have been retained as an expert on behalf of Arm to assess and provide testimony regarding whether damages are adequate to compensate Arm for the harm caused by Defendants' breach of the Nuvia ALA. For purposes of this report, and to address this issue, I

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[1] Complaint, August 31, 2022, pp. 16 – 18.
[2] Complaint, August 31, 2022, pp. 10 – 11; ARM_00111064 – 080 at 078.
[3] [redacted]
[4] Complaint, August 31, 2022, pp. 13 – 16; ARM_00111064 – 080 at 077.
[5] Complaint, August 31, 2022, pp. 16 – 18; ARM_00111064 – 080 at 077. I am informed and understand that Arm is not requesting that any silicon (physical computer chips) made before Qualcomm's acquisition be destroyed, to the extent there are any.

was asked to assume that Defendants are found liable for breach of the Nuvia ALA. I offer no opinion regarding liability.

3. I have also been asked to assess and provide testimony regarding the damages associated with Arm's claim for trademark infringement. I offer no opinion regarding liability.

4. My analysis, as set forth in this report, is based on information available to me as of the date of this report.

II. CREDENTIALS AND COMPENSATION

5. I am a Senior Managing Director of J.S. Held LLC ("J.S. Held"), a global consulting firm providing specialized technical, scientific, financial, and advisory services.[6] I currently serve as the firm's Intellectual Property Practice Lead. For more than 25 years, I have provided economic and financial consulting services in a variety of litigation matters and disputes, including intellectual property, breach of contract, business interruption, valuation, and general damage assessments. These services have included analyses of irreparable harm, lost sales, lost wages, lost profits, incremental profits, price erosion, reasonable royalties, product line profitability, fixed and variable costs, cash flows, and other related financial information. I have consulted with numerous publicly traded and closely held companies in a variety of industries, including software, medical products, biotechnology, electronics, semiconductors, Internet, telecommunications, consumer products, food services, oil and gas, and others. Within the semiconductor and integrated circuit industry, my experience includes testimony and consultation on matters involving licensing disputes, patent infringement, and trade secret misappropriation related to silicon chip fabrication, integrated circuits for power conversion, as

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[6] J.S. Held and its affiliates and subsidiaries are not a certified public accounting firm and do not provide audit, attest, or any other public accounting services. J.S. Held is not a law firm and does not provide legal advice.

well as components and functionality within mobile devices, automobiles, and Field Programable Gate Arrays ("FPGAs").

6. I am a Certified Public Accountant ("CPA"), licensed in Texas, and a Certified Valuation Analyst ("CVA"). I am a member of the American Institute of CPAs ("AICPA"), the Texas CPA Society, and the National Association of Certified Valuators and Analysts ("NACVA"). I am also a member of the Licensing Executives Society ("LES"), an organization of more than 2,500 members, including corporate executives and professionals involved in the licensing and valuation of patents, trademarks, and other intellectual property. Additionally, I have served as a Guest Lecturer at the Chicago-Kent College of Law, the Georgetown University Law Center, the John Marshall Law School, and the University of Oregon Law School on topics including accounting, valuation of intellectual property, and intellectual property management. I have been named by *Intellectual Asset Management* as one of the leading patent damages experts in the United States. Attached as Schedule 1 to this report is a summary of my professional background and testifying experience, including all publications over the last ten years and all expert testimonies over the last four years.

7. J.S. Held is compensated for my team's involvement in this matter based upon J.S. Held's hourly billing rates. My time is currently billed at a rate of $695 per hour. J.S. Held's fee is not contingent upon the outcome of this litigation or the opinions that I express.

III. INFORMATION REVIEWED AND CONSIDERED

8. In connection with the preparation of this report, I have reviewed and considered information from a variety of sources, including documents and data produced by the parties; legal documents (and related exhibits); deposition testimony (and related exhibits); and publicly available information, articles, press releases, and Internet websites. The documents and other information that I have reviewed and considered as of the date of this report include those cited

throughout this report (including the footnotes) as well as those listed on Schedule 2 attached to this report. I have also held discussions with Arm personnel, including Will Abbey (Executive Vice President & Chief Commercial Officer at Arm), Christine Tran (Senior Director of Legal at Arm), and Paul Williamson (Senior Vice President and General Manager of IoT Line of Business at Arm), as well as Arm's technical expert, Robert Colwell, Ph.D. In addition, I have reviewed and considered the following deposition transcripts (and related exhibits):[7]

Arm Personnel

- Will Abbey, Executive Vice President & Chief Commercial Officer
- Jonathan Armstrong, Head of Brand and Creative Services
- Lynn Couillard, Vice President of Sales
- Richard Grisenthwaite, Executive Vice President & Chief Architect
- Rene Haas, Chief Executive Officer
- Tim Herbert, Vice President of North American Sales (retired)
- Simon Segars, Former Chief Executive Officer
- Karthik Shivashankar, Senior Director of Wearables and Commercial Licensing
- Christine Tran, Senior Director of Legal (rough transcript)
- Ian Thornton, Vice President of Investor Relations (rough transcript)
- Paul Williamson, Senior Vice President and General Manager of IoT Line of Business
- Mark Werkheiser, Distinguished Engineer

Nuvia Personnel

- Lynn Bos, former Technical Program Manager
- Manu Gulati, former Founder & Senior Vice President of Engineering
- Pradeep Kanapathipillai, former CPU Microarchitecture and RTL Lead
- Nitin Sharma, former CPU Verification Engineer
- Jignesh Trivedi, former CPU Verification Engineer
- Gerard Williams, III, former Founder & Chief Executive Officer

Qualcomm Personnel

- Cristiano Amon, President and Chief Executive Officer
- Ziad Asghar, Senior Vice President of Product Management
- Geeta Balakrishnan, Principal Engineer in the CAD Team

[7] I understand that certain final deposition transcripts were not yet available to me at the time I submitted my Report. Accordingly, I may supplement my Report to incorporate the content of those final deposition transcripts.

- Ramakrishna Chunduru, former Chief Procurement Officer
- Michael Roberts, Vice President of Global Marketing
- Laura Sand, Senior Vice President, Legal Counsel
- Rohit Singh, Director of Program Management
- James Thompson, Chief Technology Officer

9. In forming my opinions in this case, I have relied upon the information and documents identified in this report, and I have also relied upon my more than 25 years of experience and expertise in analyzing remedies for misuse of intellectual property, analyzing the adequacy of damages to compensate for harms relating to the misuse of intellectual property, and assessing and calculating damages adequate to compensate for such harms. My analysis in this case is ongoing. Should additional information, such as documents or data provided by the parties, testimony, whether through expert report or deposition, or rulings issued by the Court, come to my attention after the date of this report, I may find it necessary to update or revise my analysis, opinions, and conclusions. I reserve my right to do so.

IV. LEGAL FRAMEWORK FOR DAMAGES

10. I am not an attorney and do not intend to provide any legal opinion. In forming my opinions, I have assumed a breach of the Nuvia ALA termination provisions.

11. I am informed and understand that if Defendants breached the ALA, then Arm is entitled to recover monetary damages or, alternatively, to specific performance of Defendants' contractual obligation(s) including the termination provision of Section [redacted] of the Nuvia ALA.

12. I am informed and understand that specific performance is appropriate only if monetary damages are not adequate to compensate Arm for the harm (including future harm) caused by Defendants' breach of the Nuvia ALA.

13. I am informed and understand that monetary damages are not adequate to compensate Arm for harm (including future harm) if those damages cannot be determined with reasonable certainty. I am informed and understand that "reasonable certainty" requires that

damages be established to a reasonable degree of certainty (or fair degree of probability), but does not require absolute certainty, absolute assurance, or mathematical exactitude as to the precise amount of damages. I am informed and understand that damages are not "reasonably certain" where they are merely speculative or conjectural.

V. SUMMARY OF OPINIONS

14. In my opinion, if Defendants are found liable for breach of the Nuvia ALA but are not ordered to discontinue the use and distribution of [redacted] then monetary damages are not adequate to compensate Arm for the harm (including future harm) caused by Defendants' breach of the Nuvia ALA.

15. In my opinion, the monetary damages associated with the harm to Arm (including future harm) caused by Defendants' breach of the Nuvia ALA (if Defendants are not ordered to discontinue the use and distribution of [redacted] cannot be determined with reasonable certainty. In my opinion, the monetary damages associated with the following harms that may result from Defendants' breach of the Nuvia ALA, individually and collectively, cannot be determined with reasonable certainty:

- disruption to Arm's ability to control the use and distribution of Arm's intellectual property (including [redacted]) and to maintain Arm's licensing ecosystem;
- significant negative impact on Arm's first mover advantage;
- harm to Arm's expansion into new segments and markets;
- a decrease in licensing revenue and investment in research and development; and
- a decrease in Arm's reputation and goodwill.

16. As it relates to the disruption to Arm's ability to control the use and distribution of Arm's intellectual property (including [redacted]) and to maintain Arm's licensing ecosystem, Defendants' breach of the ALA could have a cascade of significant effects including:

- existing and prospective Arm licensees could demand more favorable terms and lower royalties to account for increased risk;
- existing and prospective licensees could exploit development and financial terms of other licensees in unexpected ways to compete against Arm's partners;
- Arm will not be able to rely on provisions in its existing and prospective licenses to protect its intellectual property (including [redacted]);
- third parties and end users may shift to Nuvia-based Cores (discussed below); and
- existing and prospective licensees may shift away from Arm chips.

17. Several factors relating to Arm's intellectual property (including [redacted]) and the industry and market segments in which Arm's intellectual property is implemented exacerbate the difficulty of determining the monetary damages associated with the above harms, individually and collectively, with reasonable certainty. Those factors include the following:

- Qualcomm is a long-term Arm licensee and one of Arm's largest licensees by revenue which may magnify the signal sent to existing and prospective Arm licensees about Arm's ability to control its intellectual property;
- The relative speed with which the CPU industry develops which means that the short-term as well as longer-term harms resulting from Defendants' breach are difficult to predict and could lead to large and unforeseeable impacts (*e.g.*, in a "butterfly effect" type manner);
- The acute uncertainty of the harms given the actions of current and prospective licensees, and unknown emerging market segments, among other uncertainties. Such factors include (but are not limited to) the inability to quantify the number prospective licensees and related revenue,

as well as the difficulty in measuring the financial impact of actions that current and prospective licensees may take based on the decisions of other licensees.

VI. BACKGROUND

A. Industry Overview

i. CPU Background

18. Modern computing devices (including mobile phones, personal computers, cloud computing devices, servers and autonomous vehicles) operate by the use of a central processing unit ("CPU"), sometimes simply referred to as a "processor."[8] CPUs are the component of a computing device which "performs arithmetic, logic, and other operations to transform data input into more usable information output," and are comprised of "a complex set of electronic circuitry that runs the machine's operating system and apps."[9] A "CPU core" or "processor core" is the "processing unit within the CPU that can execute instructions. The more cores a CPU has, the more tasks it can handle simultaneously."[10] The number of cores within a CPU can vary "depending on their intended use case. For example, a mobile-focused CPU might have fewer cores in order to conserve battery life, while a desktop-focused CPU might have more cores for improved performance."[11] One or more CPUs (each including one or more cores) can be integrated onto a System-on-a-Chip ("SoC").[12] An SoC is a single package that contains one or more CPUs (each including one or more cores) along with other components such as "memory, input and output ports, peripheral interfaces and secondary storage devices."[13]

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[8] https://semiengineering.com/knowledge_centers/integrated-circuit/ic-types/processors/central-processing-unit-cpu/; Discussions with Robert Colwell.
[9] https://www.arm.com/glossary/cpu; Discussions with Robert Colwell.
[10] https://www.lenovo.com/us/en/glossary/cpu-core/.
[11] https://www.lenovo.com/us/en/glossary/cpu-core/; Discussions with Robert Colwell.
[12] https://www.arm.com/glossary/soc-development; https://www.arm.com/glossary/cpu.
[13] https://www.arm.com/glossary/soc-development; https://www.arm.com/glossary/cpu; Discussions with Robert Colwell.

19. A CPU is defined by architecture that allows the CPU to interface between the hardware of a computing device and its software.[14] These interfaces are referred to as "instruction set architectures" or "ISAs."[15] There are two different architectures, or "schools of thought," "about how a processor's [ISA] is designed:" Complex Instruction Set Computers ("CISC") and Reduced Instruction Set Computer ("RISC").[16] CISC architecture "supports complex instructions that can be carried out across multiple clock cycles, while RISC must use simple instructions that can be executed within a single cycle."[17] The most commonly used architecture for ISAs is RISC.[18] RISC is "is an alternative to the Complex Instruction Set Computing (CISC) architecture and is often considered the most efficient CPU architecture technology available today."[19] When compared to CISC, RISC has a "significantly higher architecturally-determined performance."[20] ARM, or "Advanced RISC Machine" is a specific family of instruction set architecture that is based on RISC and was developed by Arm.[21] Arm architecture, including its RISC-based ISAs, are "are common in smartphones, tablets, laptops, gaming consoles and desktops, as well as a growing number of other intelligent devices."[22]

20. The global market for microprocessor chips is estimated to increase from $106 billion in 2022 to $185.39 billion by 2032, at a compound annual growth rate ("CAGR") of 5.8%.[23] With this comes the continued efforts to innovate the microprocessor market. A "common

[14] https://www.arm.com/glossary/isa; Discussions with Robert Colwell.
[15] https://www.arm.com/glossary/isa; Discussions with Robert Colwell.
[16] https://www.gigabyte.com/Glossary/cisc; Discussions with Robert Colwell.
[17] https://www.gigabyte.com/Glossary/cisc.
[18] https://www.precedenceresearch.com/microprocessor-market.
[19] https://www.arm.com/glossary/risc.
[20] Bhandarkar, Dileep, and Douglas W. Clark. "Performance from architecture: comparing a RISC and a CISC with similar hardware organization." *Proceedings of the fourth international conference on Architectural support for programming languages and operating systems*. 1991, p. 318.
[21] https://www.arm.com/glossary/risc.
[22] https://www.arm.com/glossary/risc.
[23] https://www.precedenceresearch.com/microprocessor-market.

advancement[] in CPU technology is making []transistors smaller and smaller."[24] A smaller process node (which is comprised of transistors that are used to "perform all the of number crunching and data storage done inside the chip") translates "to a higher number of calculations per second – and less energy released as heat."[25] The dramatic improvement in CPU speeds over the decades is often referred to as "Moore's Law," [26] which "is the observation that the number of transistors on an integrated circuit will double every two years with minimal rise in cost "[27]

ii. CPU Use in Various Segments

21. CPUs are used in numerous applications or segments. For example, in the mobile segment, "[t]he mobile applications processor is the primary chip in a smartphone, and runs the operating system and applications in addition to controlling many of the device functions, including gaming, music, video, and any other applications. While high compute performance is required for today's applications, processors also must be highly energy efficient so that the smartphone's battery will last all day without needing to be recharged."[28] Mobile applications processors are expected to handle even more processing capabilities with the increase in "high-performance processing capabilities, including the shift to 5G, growth in mobile gaming, and emergence of AI and ML workloads."[29]

22. CPUs are also widely used in consumer electronics, which include "products found in the home, such as digital TVs, tablets, laptops, [and] extended reality ('XR') headsets and wearables."[30]

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[24] https://www.digitaltrends.com/computing/what-is-a-cpu/.
[25] https://www.techspot.com/article/1856-aiming-for-atoms-chip-manufacturing/.
[26] https://www.digitaltrends.com/computing/what-is-a-cpu/.
[27] https://www.intel.com/content/www/us/en/newsroom/resources/moores-law.html.
[28] ARM_01259705 – 0105 at 9718.
[29] ARM_01259705 – 0105 at 9718.
[30] ARM_01259705 – 0105 at 9718.

23. CPUs are also used in the embedded segment or "Internet of Things" ("IoT") where they are included in a "wide range of goods, including washing machines, thermostats, digital cameras, drones, sensors, surveillance cameras, manufacturing equipment, robotics, electronic motor controllers and city infrastructure and building management equipment."[31]

24. The automotive market also uses CPUs for tasks such as "IVI [in-vehicle-infotainment], ADAS [Advanced Driver Assistance Systems], engine management, and body and chassis control."[32] CPUs in vehicles are "expected to increase as ADAS, electrification, IVI, and eventually autonomous driving, accelerate requirements for higher compute performance in newly manufactured vehicles."[33]

25. Within the networking equipment segment, CPUs are "deployed into wireless networking such as base-station equipment, enterprise Wi-Fi, and wired networking equipment such as routers and switches. The market is growing as more wired and wireless infrastructure is deployed, as much of the data consumed in the cloud is created at the edge and needs to be transmitted over networks to the data center for processing."[34]

26. CPUs in the cloud compute, data center, and server segment are used in "the main server chips, data processing units (DPUs), and smart network interface cards (SmartNICs) used by [cloud service providers] to run their operations. The increase in cloud computing has been driven by the rapid increase in data traffic generated by consumers and enterprises globally and by the migration of enterprise workloads to the cloud."[35] Server CPUs "serve[] as a crucial component responsible for processing instructions and commands within a server. Its role

[31] ARM_01259705 – 0105 at 9718.
[32] ARM_01259705 – 0105 at 9719.
[33] ARM_01259705 – 0105 at 9719.
[34] ARM_01259705 – 0105 at 9719.
[35] ARM_01259705 – 0105 at 9719.

encompasses tasks such as retrieving and executing instructions, processing data, and undertaking various computational functions like serving web pages and executing database queries. As the linchpin of server functionality, the CPU plays a pivotal role in determining the computing capabilities of servers. The responsiveness and overall performance of a server are heavily influenced by the efficiency of its CPU."[36] It is my understanding that a server CPU works in four basic steps:[37]

- Fetch: "The CPU retrieves instructions from memory, interprets them, and determines the next operation to be performed."
- Decode: "All instructions or commands undergo translation into assembly instructions. During this stage, the server CPU decodes the assembly code, converting it into understandable binary instructions."
- Execute: "The CPU carries out instructions using calculations and technical algorithms, producing processed data as output."
- Store: "Following the execution of instructions, the CPU stores the output data back into the memory. This sequence of operations forms the core functioning of a server CPU, enabling it to process and manage data effectively."

27. The performance of server CPUs can be measured based on the number of cores, number of threads, and clock speed.[38] I understand that server processors differ from personal computer processors.[39] Server processors are built to withstand ample amounts of data and serve multiple users, requiring highly reliable components with enterprise-grade cache requirements.[40]

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[36] https://community.fs.com/article/what-is-a-server-cpu.html.
[37] https://community.fs.com/article/what-is-a-server-cpu.html.
[38] https://www.gigabyte.com/Article/server-processors-the-core-of-a-server-s-performance.
[39] https://www.gigabyte.com/Article/server-processors-the-core-of-a-server-s-performance.
[40] https://www.gigabyte.com/Article/server-processors-the-core-of-a-server-s-performance.

B. Arm

28. Arm is described as "the industry leader of CPUs" that is relied on by "the world's leading semiconductor companies and OEMs."[41] Arm is also known as [redacted].[42] Arm was established in 1990, was first publicly listed on the NASDAQ in 1998, and is headquartered in the United Kingdom.[43] Since its founding, Arm has spent decades developing "the most pervasive CPU architecture in the world," which includes not only CPU products but also a "portfolio of products that are deployed alongside [its] CPUs," such as graphics processing units ("GPUs"), system IP, compute platform products, as well as development tools and software.[44] Arm has invested significantly in developing its architectures and accompanying verification suites over more than 30 years as it has developed an ecosystem benefiting all Arm-compatible chips.[45] Arm continues to develop newer and more improved offerings backed by its intellectual property portfolio, and is currently on version 9 ("Arm v9") as the next generation of Arm architecture offerings.[46] Arm's offerings [redacted][47] Arm notes that, as of December 31, 2022, the aggregate value of Arm-designed or Arm-compatible chips had a share of approximately 48.9%.[48] In 2022, Arm's revenue was approximately $2.7 billion.[49]

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[41] ARM_01259705 – 0105 at 9712.
[42] ARM_01427450 – 492 at 451.
[43] ARM_01259705 – 0105 at 9713 – 9714.
[44] ARM_01259705 – 0105 at 9716.
[45] Deposition of Simon Segars, November 16, 2023, p. 47.
[46] https://www.arm.com/architecture/cpu.
[47] [redacted]
[48] ARM_01259705 – 0105 at 9718.
[49] ARM_01259705 – 0105 at 9713.

29. Arm partners with companies of varying size.[50] With "thousands of partners, [Arm's] customers can go to market faster with [] products that customers demand."[51,52] Companies such as Indie Semiconductor, Phoenix Technologies, MediaTek, Maven Silicon, and many others participate in Arm's partnership program.[53] Arm's licensees and partners comprise thousands of companies throughout the supply chain for semiconductor products, including the following: [54,55]

- **Design Companies (or "fabless")**—These are companies that design CPUs and SoCs but do not operate manufacturing facilities and instead outsource the manufacturing of CPUs and SoCs. Examples of Arm licensees include Qualcomm, Nordic Semi, and MediaTek.

- **Fabrication Companies (or "fabs" or "foundries")** —These are companies that manufacture CPUs and SoCs, and may manufacture chips for other companies based on their designs that are provided to them. Examples of Arm licensees include STMicroelectronics and Samsung.

- **End-User Device Manufacturers** —These are companies that manufacture and sell end-user devices (*e.g.*, mobile phones, personal computers) that incorporate CPUs and SoCs. Examples of Arm licensees include Apple and Lenovo.

30. In addition, Arm boasts the industry's largest software ecosystem with over 15 million developers and 10 million apps supported by operating systems such as Android, iOS, Linux, and Windows, among others.[56]

31. Arm's technology has been widely adopted. As of December of 2022, Arm's share across applicable industries was approximately 48.9% (equaling $98.9 billion in chip value based

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[50] https://www.arm.com/partners.
[51] https://www.arm.com/partners.
[52] [redacted]
[53] https://www.arm.com/partners; ARM_01259705 – 0105 at 9720.
[54] https://www.arm.com/partners; ARM_01259705 – 0105 at 9720; [redacted]
[55] [redacted]
[56] ARM_01427450 – 492 at 458.

on Arm chips).[57] Noted in its 2nd Amended 2023 F-1, Arm concludes, "…we will be able to contribute a greater proportion of the technology included in each chip, resulting in our royalties comprising a greater proportion of each chip's total value."[58]

32. As of 2022, [redacted].[59] In addition, [redacted].[60]

33. Arm's has a strong presence in mobile applications processors.[61] Since 2016, Arm has sought to "further develop and market [its] products to build on [its] success in powering the world's smartphones and other consumer electronic devices."[62] Specifically, Arm has "focused in recent years on making Arm the ubiquitous provider of compute technology in all market segments by expanding into new markets, including cloud computing, networking, automotive, and IoT, most of which have strong secular tailwinds."[63] However, the cloud computing (*i.e.*, server) market in particular is dominated by x86 CPUs,[64] which "are ubiquitous in today's data centers and IT infrastructure because they profit from the complete hardware and software ecosystem that is the result of Intel and AMD's long years of developing the market; they also offer incredibly fast response time and excel at tackling complex workloads through multithreading."[65] Indeed, a May 2021 IBS semiconductor industry report indicated Intel's share in the data center CPU market is significant with AMD seeking to increase its share.[66] In addition,

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[57] ARM_01259705 – 0105 at 9713.
[58] ARM_01259705 – 0105 at 9718.
[59] ARM_01427450 – 492 at 451.
[60] ARM_01427450 – 492 at 452.
[61] ARM_01259705 – 0105 at 9718.
[62] ARM_01259705 – 0105 at 9714.
[63] ARM_01259705 – 0105 at 9714.
[64] Discussions with Will Abbey.
[65] https://www.gigabyte.com/Article/server-processors-the-core-of-a-server-s-performance.
[66] ARM_00088045 – 303 at 070, 074, 127, and 129; *see also* [redacted]

Arm has noted that:

[redacted]

34. Arm states that "[r]esearch and development is at the heart of [its] business and critical to [its] future success. Accordingly, [it has] always invested, and will continue to invest, significant resources in [its] R&D program. [Arm's] vision to invest and develop new products is driven by [its] desire to maintain or increase [its] market share and create value for [its] customers."[68] As part of its R&D efforts, Arm had approximately 6,000 individuals employed globally as of March 31, 2023, with approximately 80% of their workforce focused on research and development efforts in the previously stated markets.[69] Because of its R&D investments, as of March 31, 2023, Arm had over 6,800 U.S. and foreign patents, and 2,700 patent applications pending worldwide.[70]

35. Arm's business model is built on its licensing ecosystem.[71] Arm offers two main types of licenses: Technology License Agreements ("TLAs") and Architecture License Agreements ("ALAs").[72] In general, Arm provides access to its intellectual property, including the [redacted], and Arm-designed and created Register Transfer Level ("RTL") blocks that can be used to create files used to actually make CPUs and other components.[73] In return, licensees provide royalty payments to Arm, which can differ

[67] ARM_00088656 – 684 at 667; *See also* QCARM_3314892 – 915 at 899.
[68] ARM_01259705 – 0105 at 9804.
[69] ARM_01259705 – 0105 at 9713.
[70] ARM_01259705 – 0105 at 9721.
[71] Discussions with Will Abbey and Christine Tran.
[72] Discussions with Will Abbey and Christine Tran.
[73] *See, e.g.*, QCARM_2426822 – 836; Discussions with Will Abbey and Christine Tran.

based on the deliverables and versions of Arm intellectual property delivered under the licensees' agreement(s).[74]

36. The vast majority of Arm's licenses are TLAs, and historically most Arm customers have a TLA.[75] A TLA provides a license to use [redacted] which is defined in one or more annexes to the TLA.[76] In a TLA, the [redacted] is [redacted][77] The licensee selects the Arm-designed components that it needs and Arm then delivers, among other things, the ready-to-implement RTL blocks (or RTL code) corresponding to the selected components.[78] In exchange, the TLA licensee "pays a fixed license fee" to Arm.[79] The amount paid for the licensing fee "depends on which products are being licensed, the term during which the licensee is able to design [Arm] products covered by the license [], and the number of chip products of the licensee that may use [Arm] products."[80] In addition to license fees, Arm also receives "a per-unit royalty on substantially all Arm-based chips shipped by [its] customers.[81]

37. An ALA from Arm, in contrast to a TLA, provides a license grant to use the [redacted] (defined in the ALA) to develop custom processor cores and other components of CPUs and SoCs.[82] In contrast to a TLA, Arm does not provide Arm-designed components (or RTL blocks) to the licensee under the ALA; rather, the licensee works (with Arm's support) to

[74] *See, e.g.*, QCARM_2426822 – 836 at 828; *see also* [redacted]
[75] ARM_01259705 – 0105 at 9794; [redacted]
[76] *See, e.g.*, QCARM_2426822 – 836 at 822 – 826; Discussions with Will Abbey and Christine Tran.
[77] Discussions with Christine Tran.
[78] Discussions with Christine Tran.
[79] ARM_01259705 – 0105 at 9833.
[80] ARM_01259705 – 0105 at 9833.
[81] ARM_01259705 – 0105 at 9793.
[82] *See, e.g.*, ARM_00111064 – 080 at 064 – 070; Discussions with Christine Tran; Deposition of Christine Tran, December 19, 2023, p. 66 (rough transcript)

create custom Arm-compatible CPUs, cores, and other components of CPUs or SoCs—each of which is based on [redacted] and is compatible with the Arm instruction set architecture.[83] Arm has granted fewer ALAs than TLAs.[84] Arm also provides support and maintenance to ALA licensees in developing Architecture Compliant Products.[85] For an ALA, the licensee pays an architecture license fee and "a royalty on every chip that contains the Arm-compliant design."[86] Arm ALA licensees also may have an Arm TLA.[87] Because CPU optimization is costly and time consuming, ALA licensees often also license Arm designs under a TLA and then use those Arm designs as complementary components alongside the licensee's custom Arm-compatible designs created under their ALA to design or manufacture a product, *e.g.*, an SoC.[88]

38. Arm has built and continues to build a strong relationship with its partners through investment in Arm's licensing ecosystem, including TLAs and ALAs and, in turn, has developed a long-term recurring revenue stream that is reinvested in research and development to continue to improve and optimize Arm's technology.[89]

39. As a company focused on licensing its intellectual property, Arm considers it to be critical to safeguard [redacted].[90] As Mr. Abbey (Arm's Executive Vice President & Chief Commercial Officer) testified during his deposition: [redacted]

[83] Discussions with Christine Tran.
[84] Deposition of Tim Herbert, October 25, 2023, p. 55; Discussions with Will Abbey and Christine Tran.
[85] *See, e.g.*, ARM_00111064 – 080 at 064 and 073 – 074; Discussions with Will Abbey and Christine Tran.
[86] ARM_01259705 - 0105 at 9834.
[87] Deposition of Will Abbey, October 27, 2023, p. 91.
[88] ARM_01259705 - 0105 at 9793.
[89] Discussions with Will Abbey and Paul Williamson.
[90] [redacted]

[redacted] Mr. Abbey also testified that [redacted] Mr. Williamson testified that [redacted] Similarly, Mr. Williamson testified that [redacted]

40. Arm implements license provisions in order to protect its intellectual property (including [redacted]) and licensing ecosystem, and relies on those provisions to ensure that it can continue to invest in research and development and to support its partners.[95] For example, Arm requires that a party have a license when it does any development work using Arm's intellectual property and that the scope and terms of the license are defined in advance.[96] Arm's TLAs and ALAs define the nature and scope of Arm's intellectual property to be delivered, the nature and scope of the license to use Arm's intellectual property, and the financial compensation to be paid to Arm in exchange for the use of Arm's intellectual property.[97]

41. For example, Arm's TLAs and ALAs include provisions providing that [redacted]

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91 [redacted]
92 [redacted]
93 [redacted]

95 Discussions with Paul Williamson and Christine Tran.
96 Discussions with Paul Williamson and Christine Tran.
97 Discussions with Paul Williamson and Christine Tran.

[redacted] For example, Section [redacted] of the Nuvia ALA includes the following [redacted]:

[redacted]

42. Arm's TLAs and ALAs also include provisions providing that Arm can terminate the license under certain circumstances.[100] Those termination provisions require that Arm licensees discontinue the use and distribution of [redacted], and any products embodying such technology and information on termination of their agreement.[101] For example, Section [redacted]

[redacted]

43. These protections are critical to Arm's business.[103] If Arm could not enforce the protections included in its TLAs and ALAs, then licensees could misuse Arm's intellectual

98 Discussions with Paul Williamson and Christine Tran.
99 ARM_00111064 – 080 at 078.
100 Discussions with Paul Williamson and Christine Tran.
101 Discussions with Paul Williamson and Christine Tran.
102 ARM_00111064 – 080 at 077.
103 Discussions with Paul Williamson and Christine Tran.

property and the damage to Arm's intellectual property and licensing ecosystem would be significant.[104]

C. Qualcomm

44. Qualcomm is one of the world's largest semiconductor companies, developing products directed to wireless communications, networking, personal computers, cell phones, automobiles, and other high-tech electronic devices.[105] Qualcomm's primary focus is on the mobile market, where it markets and develops its "Snapdragon" CPU products on a worldwide scale.[106] Qualcomm is one of Arm's largest partners, accounting for approximately [redacted] of Arm's annual revenue.[107] Qualcomm has an ALA and TLA with Arm.[108] Arm and Qualcomm executed the first TLA in September 1997 and first ALA in September 2003.[109] I understand that prior to acquiring Nuvia (discussed below), [redacted]

45. Qualcomm, via QCT ("Qualcomm CDMA Technologies"), "utilizes a fabless production model, which means that [it] do[es] not own or operate foundries for the production of silicon wafers from which [its] integrated circuits are made."[111] Qualcomm's reliance on third-party licensing and manufacturing contracts negates the need for procurement of raw materials.[112] This segment holds significant importance to Qualcomm as "[d]ie cut from silicon

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[104] Discussions with Will Abbey and Paul Williamson.
[105] https://www.investopedia.com/articles/markets/012216/worlds-top-10-semiconductor-companies-tsmintc.asp; https://www.qualcomm.com/products.
[106] https://www.qualcomm.com/snapdragon/overview; Qualcomm Inc. Form 10-K for the fiscal year ended September 24, 2023, p. 31; Deposition of Ramakrishna Chunduru, October 30, 2023, p. 40.
[107] ARM_01259705 – 0105 at 9754.
[108] ARM_00060458 – 512; ARM_00044650 – 692.
[109] ARM_00095370 – 449 at 370.
[110] [redacted]
[111] https://investor.qualcomm.com/segments/qct; Qualcomm Inc. Form 10-K for the fiscal year ended September 24, 2023, p. 11.
[112] Qualcomm Inc. Form 10-K for the fiscal year ended September 24, 2023, pp. 4 and 11 - 12.

wafers are the essential components of all of [its] integrated circuits and a significant portion of the total integrated circuit cost."[113] The primary foundry suppliers for QCT include Samsung Electronics, Semiconductor Manufacturing International Corporation, and TSMC and generally take place in the Asia-Pacific region.[114]

46. In addition to licensing intellectual property (*e.g.*, from Arm), Qualcomm also has a licensing entity referred to as QTL ("Qualcomm Technology Licensing").[115] QTL grants licenses or otherwise provides rights to use portions of Qualcomm's intellectual property portfolio, which includes certain patent rights essential to and/or useful in the manufacture and sale of certain wireless products.[116] A significant portion of QTL's licensing revenues are derived from agreements and grants under Qualcomm's cellular standard-essential patents.[117]

D. Nuvia and the Nuvia ALA

47. Nuvia was a semiconductor company founded in early 2019 by three former Apple engineers: Gerard Williams III, Manu Gulati, and John Bruno.[118] Nuvia was formed with the aim of developing energy-efficient server CPUs based on Arm architecture for use in data centers.[119]

48. In September 2019, Nuvia executed an ALA with Arm as well as a TLA ("Nuvia TLA").[120] The Nuvia ALA included a [redacted] provision, which defined [redacted] as shown below:[121]

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[113] Qualcomm Inc. Form 10-K for the fiscal year ended September 24, 2023, p. 12.
[114] Qualcomm Inc. Form 10-K for the fiscal year ended September 24, 2023, p. 12.
[115] Qualcomm Inc. Form 10-K for the fiscal year ended September 24, 2023, p. 7.
[116] Qualcomm Inc. Form 10-K for the fiscal year ended September 24, 2023, p. 7.
[117] Qualcomm Inc. Form 10-K for the fiscal year ended September 24, 2023, p. 12.
[118] NuVia, Inc., Private Company Profile, *S&P Capital IQ*.
[119] QCARM_3314892 – 915 at 893; https://web.archive.org/web/20210115193713/https://nuviainc.com/; *see also* Deposition of Tim Herbert, October 25, 2023, pp. 28 and 31; Deposition of Richard Grisenthwaite, November 15, 2023, p. 62; Deposition of Nitin Sharma, October 27, 2023, p. 38.
[120] ARM_00111064 – 090 at 064; QCARM_2426822 – 836.
[121] Discussions with Christine Tran.

[redacted]

49. Section [redacted], in turn, referred to [redacted] and [redacted] which are shown below:

[redacted]

50. [redacted]

[redacted]

[122] ARM_00111064 – 080 at 064.
[123] ARM_00111064 – 080 at 064.
[124] ARM_00111064 – 080 at 064.
[125] *See, e.g.*, ARM_00111064 – 080 at 078; Discussions with Will Abbey and Christine Tran.
[126] ARM_00111064 – 060 at 078.

51. [redacted][129]

[redacted]

52. I understand that Nuvia worked from 2019 through early 2021 to develop a custom processor core for the server market based on Arm architecture.[131] Arm provided significant support to Nuvia during its development of an Arm-based core for the server market.[132] In August 2020, Nuvia (in collaboration with Arm) had appeared to succeed, and announced its "first-generation CPU, code-named 'Phoenix.'"[133] [redacted]

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[127] *See, e.g.*, ARM_00111064 – 080 at 077; Discussions with Christine Tran
[128] *See, e.g.*, ARM_00111064 – 080 at 077; Discussions with Christine Tran.
[129] ARM_00111064 – 080 at 077.
[130] ARM_00111064 – 080 at 077.
[redacted]
https://www.qualcomm.com/news/releases/2021/03/qualcomm-completes-acquisition-nuvia.
[132] Deposition of Richard Grisenthwaite, November 15, 2023, pp. 77 – 78.
[133] https://medium.com/silicon-reimagined/performance-delivered-a-new-way-8f0f5ed283d5.
[134] [redacted]

53. Nuvia had its initial round of Series A funding in November of 2019 that raised $53 million.[135] Dell Technologies Capital, among other investment groups, were involved in the round of funding.[136] Nuvia based cores, developed with support from Arm, had begun to gain significant traction throughout the industry.[137] In September 2020, Nuvia raised $240 million in Series B funding with plans to "deliver industry leading CPU performance to the data center."[138]

E. Qualcomm's Acquisition of Nuvia and Continued Development of Nuvia-based Cores

54. On January 27, 2021, Qualcomm notified Arm that Qualcomm had [redacted] [redacted]9 Qualcomm acknowledged that [redacted][140] [redacted][141] Qualcomm asked for a response in one week, on February 3, 2021, [redacted]

[135] https://web.archive.org/web/20210422062904/https://nuviainc.com/nuvia-raises-53-million-to-reimagine-silicon-design-for-the-data-center/.
[136] https://web.archive.org/web/20210422062904/https://nuviainc.com/nuvia-raises-53-million-to-reimagine-silicon-design-for-the-data-center/.
[137] Deposition of Richard Grisenthwaite, November 15, 2023, pp. 77 – 78; QCARM_0584334 – 345 at 336.
[138] https://web.archive.org/web/20210316180114/https://nuviainc.com/.
[139] ARM_00032601 – 602 at 602.
[140] ARM_00032601 – 602 at 602.
[141] ARM_00032601 – 602 at 602.
[142] ARM_00032601 – 602 at 602.

55. Arm responded to Qualcomm's January 27, 2021 letter on February 2, 2021, congratulating Qualcomm on the news of the acquisition and indicating that it would execute the due diligence review of Nuvia's contracts with Arm.[143] Arm reminded Qualcomm that [redacted][145]

56. Qualcomm responded on February 3, 2021.[146] [redacted][149]

[143] ARM_00048483 – 484 at 484.
[144] ARM_00048483 – 484 at 484.
[145] ARM_00048483 – 484 at 484.
[146] ARM_00032623 – 625.
[147] ARM_00032623 – 625 at 624.
[148] ARM_00032623 – 625 at 624.
[149] ARM_00032623 – 625 at 624.

57. [redacted][150]

58. On March 15, 2021, Qualcomm completed the acquisition of Nuvia, and stated it would be transitioned into the QCT branch of the company.[151] Nuvia was purchased for approximately $1.3 billion.[152] Qualcomm reported, "Qualcomm Technologies expects to integrate next generation CPUs across a wide portfolio of products, including powering flagship smartphones, laptops, and digital cockpits, as well as Advanced Driver Assistance Systems, extended reality, and infrastructure networking solutions.[153] The purchase price allocation included tangible assets, intangible assets, and liabilities.**[154]**

59. For over a year, Arm and Qualcomm engaged in negotiations to try to resolve their dispute and reach an agreement regarding Qualcomm's ability to continue to develop Nuvia-based Cores.[155] I understand that those discussions did not ultimately result in an agreement.[156]

60. [redacted]

[150] ARM_00032605 – 606 at 606.
[151] https://www.qualcomm.com/news/releases/2021/03/qualcomm-completes-acquisition-nuvia.
[152] Qualcomm Inc. Form 10-K for the fiscal year ended September 26, 2021, p. F-30.
[153] https://www.qualcomm.com/news/releases/2021/03/qualcomm-completes-acquisition-nuvia.
[154] Qualcomm Inc. Form 10-K for the fiscal year ended September 26, 2021, p. F-30.
[155] See, *e.g.*, ARM_01215343 – 544; ARM_01309668 – 669; ARM_00032604; ARM_01305515; ARM_00000003; ARM_00000019 – 021; ARM_00087288 – 289; ARM_01215409.
[156] Deposition of Simon Segars, November 16, 2023, p. 72; Deposition of Rene Haas, December 12, 2023, pp. 163 – 164.
[157] QCARM_0338883; QCARM_2429057.

[redacted]

61. [redacted]

62. [redacted]

158 QCARM_0338883.

159 QCARM_0338883.

160 QCARM_2426822 - 836 at 833.

161 QCARM_3337797; QCARM_0557206; QCARM_3059661.

162 QCARM_3434164.

163 In addition, in April 2022, [redacted] (*e.g.*, QCARM_3965325 – 326).

164 ARM_01305479 – 480 at 480.

[redacted]

63. [redacted][167]

64. [redacted]

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[165] ARM_01305479 – 480 at 480.
[166] QCARM_2429057.
[167] QCARM_2429057.
[168] QCARM_3059661.
[169] ARM_01238999 – 9003; *see also* ARM_01215997 – 6001 at 997 [redacted] QCARM_2417783 [redacted]

[redacted] I understand that "[redacted] is the tradename for the Phoenix Core.[171] In this report, I use "Nuvia-based Cores" to refer [redacted] I am informed and understand that Snapdragon X Elite has been described as an [redacted] product and therefore would be a Nuvia-based Core.[172] I understand that Defendants are developing other products that fit the definition of Nuvia-based Cores. including [redacted][173]

65. [redacted]

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[170] *See, e.g.*, Arm Ltd.'s Second Supplemental Objections and Responses to Qualcomm's First Set of Interrogatories (Nos. 1 and 6), November 17, 2023, pp. 4, 11 – 12, and 43 – 46; Arm Ltd.'s Supplemental Objections and Responses to Qualcomm's Third Set of Interrogatories (No. 20), November 17, 2023, pp. 5 and 11 – 12.

[171] Correspondence dated 10/26/2023, email from J. Braly to J. Li; Deposition of Mike Roberts, November 28, 2023, pp. 35 – 37.

[172] https://www.forbes.com/sites/jonmarkman/2023/12/05/qualcomms-x-elite-crushes-apple-arm-holdings-stocks-surge/?sh=5f330d9e7d04; [redacted]

[173] [redacted]

[174] ARM_01241187.

[175] ARM_01241187.

[redacted]

66. [redacted]

67. Notwithstanding Arm's correspondence with Qualcomm, Arm alleges [redacted] For example, in June 2022, Qualcomm said that its Nuvia chips will soon join the industry-wide "ecosystem transition to Arm" and that by "late next year, beginning 2024, you're going to see Windows PCs powered by Snapdragon

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176 ARM_01241187.
177 ARM_00045393.
178 ARM_00045393.
179 Arm Ltd.'s Second Supplemental Objections and Responses to Qualcomm's First Set of Interrogatories (Nos. 1 – 11), November 17, 2023, pp. 27 – 28 *see* Defendants' Answer and Defenses to Plaintiff's Complaint and Jury Demand and Defendants' Amended Counterclaim, October 26, 2022, pp. 10 and 80.

with a Nuvia-designed CPU."[180] Moreover, in November 2022, Qualcomm made clear that "the creation of our custom CPU was started by Nuvia engineers while employed at Nuvia."[181]

68. Based on Qualcomm's continued use of the Nuvia-based Cores (including the [redacted]), Arm filed this litigation.[182] Arm asserts that despite Nuvia's and Qualcomm's certifications, Defendants continued to use and develop Arm-based Technology developed under the Nuvia license agreements, including Nuvia-based Cores.[183]

VII. Damages Inadequate to Compensate for Harm

A. Summary

69. In my opinion, if Defendants are found liable for breach of the Nuvia ALA but are not ordered to discontinue the use and distribution of [redacted], and any products embodying such technology or information (including Nuvia-based Cores), then monetary damages are not adequate to compensate Arm for the harm (including future harm) caused by Defendants' breach of the Nuvia ALA. In my opinion, the monetary damages associated with the harm to Arm (including future harm) caused by Defendants' breach of the Nuvia ALA cannot be determined with reasonable certainty.

70. I have considered the harms that Defendants' breach of the Nuvia ALA may cause to Arm, based on my discussions with Arm employees and review of the record, and described those harms below. As further described below, those harms to Arm include: (A) a significant disruption to Arm's licensing ecosystem, (B) a significant negative impact on Arm's first mover

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180 Complaint, August 31, 2022, p. 14 (citing *Qualcomm CEO on What He Really Thinks of Apple*, The Daily Charge (June 9, 2022), https://podcasts.apple.com/us/podcast/qualcomm-ceo-on-what-he-really-thinks-of-apple/id1091374076?i=1000565773375).
181 Mark Hachman, *Qualcomm dubs* [redacted], PCWorld (Nov. 17, 2022), https://www.pcworld.com/article/1382740/qualcomm-dubs-nuvia[redacted]-for-2023.html.
182 Complaint, August 31, 2022.
183 Complaint, August 31, 2022, pp. 13 – 15.

advantage, (C) harm to Arm's expansion into new segments and markets, (D) a significant decrease in licensing revenue and investment in research and development, and (E) a significant decrease in Arm's reputation and goodwill. Moreover, these harms are exacerbated by several additional factors. As set forth below, monetary damages cannot adequately compensate for any of these harms (individually or collectively). Further, the damages associated with these harms (individually and collectively) cannot be determined with reasonable certainty. I address these harms in turn below.

B. Significant Disruption to Arm's Licensing Ecosystem

71. The harm to Arm's licensing ecosystem resulting from Defendants' breach of the Nuvia ALA cannot be readily quantified and the associated monetary damages cannot be reasonably ascertained. The disruption to Arm's licensing ecosystem includes many different, but overlapping, harms which cannot be quantified. The uncertainty of those harms is further exacerbated by the unprecedented situation in which a licensee is being permitted to continue to use and distribute [redacted], and products embodying such technology or information despite it doing so in breach of its license agreement (assuming that Defendants are found to have breached the Nuvia ALA and not ordered to stop using and distributing [redacted], and products embodying such technology or information).

72. For example, Mr. Williamson testified concerning [redacted][184] Mr. Williamson further testified that [redacted]

[184] Deposition of Paul Williamson, November 9, 2023, pp. 243 – 244.
[185] Deposition of Paul Williamson, November 9, 2023, p. 244.

[redacted] [redacted]

73. Mr. Abbey also stated that [redacted] [redacted] Further, Mr. Abbey testified that [redacted] [redacted] Mr. Williamson testified that [redacted] [redacted] Similarly, Mr. Williamson testified that [redacted] [redacted] Mr. Haas testified that [redacted] [redacted]

74. The harms to Arm's ecosystem may include the following: (i) existing and prospective Arm licensees could demand more favorable terms and lower royalties to account

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[186] Deposition of Paul Williamson, November 9, 2023, pp. 244 – 245.
[187] Deposition of Will Abbey, October 27, 2023, p. 361.
[188] Deposition of Will Abbey, October 27, 2023, p. 361.
[189] Deposition of Paul Williamson, November 9, 2023, p. 246.
[190] Deposition of Paul Williamson, November 9, 2023, p. 246.
[191] Deposition of Rene Haas, December 12, 2023, pp. 164 – 165.

for increased risk, (ii) existing and prospective licensees could exploit development and financial terms of other licensees in unexpected ways to compete against Arm's partners, (iii) Arm will not be able to rely on provisions in its existing and prospective licenses to protect its intellectual property, (iv) third parties and end users may shift to Nuvia-based Cores, and (v) existing and prospective licensees may shift away from Arm chips. This harm represents a significant threat to Arm's ability perpetuate its business model given its dependence on developing, licensing, and protecting its intellectual property.

i. Existing and Prospective Arm Licensees Could Demand More Favorable Terms and Lower Royalties to Account for Increased Risk

75. The harm of existing and prospective Arm licensees demanding more favorable license terms and lower royalties to account for increased risk associated with other licensees' misuse of Arm's intellectual property resulting from Defendants' breach of the Nuvia ALA cannot be readily quantified and the associated monetary damages cannot be reasonably ascertained.[192]

76. For example, current and prospective Arm licensees could consider the impact of Qualcomm or other licensees or prospective licensees breaching their license agreements, and misusing [redacted], and products embodying such technology or information.[193] This could have several impacts. For example, existing licensees may be less inclined to respect their license terms or selectively misinterpret terms which would require Arm to devote significant resources to negotiating and, potentially, enforcing those licenses.[194] The transaction costs associated with probable re-negotiations and other related

[192] Discussions with Will Abbey and Paul Williamson.
[193] Discussions with Will Abbey and Paul Williamson.
[194] Discussions with Will Abbey and Paul Williamson.

effects could result in significant harm to Arm's licensing ecosystem.[195]

77. In addition, existing and prospective licensees may seek reduced royalty rates or other concessions.[196] Given that royalties paid under Arm licenses may extend over a long period of time, a change (even a minimal change) in royalty rates (particularly for larger volume licensees) can result in a significant change in future revenue.[197] In addition, given the large number of Arm existing and prospective licensees, even a minimal change in royalty rates into the future can result in additional significant harm to Arm's licensing ecosystem.[198]

78. In my opinion, the scope of the harm of existing and prospective Arm licensees demanding more favorable terms and lower royalties to account for increased risk cannot be readily determined or quantified and the damages associated with that harm cannot be determined with reasonable certainty. Therefore, monetary damages cannot adequately compensate Arm for this harm.

ii. Existing and Prospective Arm Licensees Could Exploit Development and Financial Terms of Other Licenses in Unexpected Ways to Compete Against Arm's Partners

79. The harm of existing and prospective Arm licensees exploiting the technology developed under, and financial terms of, other Arm licensees in unexpected ways – including competing against Arm's partners -- as a result of Defendants' breach of the Nuvia ALA cannot be readily quantified and the associated monetary damages cannot be reasonably ascertained.[199] In particular, if Qualcomm is permitted to continue to use [redacted]

[195] Discussions with Will Abbey and Paul Williamson; [redacted]

[196] Discussions with Will Abbey and Paul Williamson.

[197] Discussions with Will Abbey and Paul Williamson.

[198] Discussions with Will Abbey and Paul Williamson.

[199] Discussions with Will Abbey and Paul Williamson.

[redacted], and products embodying such technology or information (provided or developed under the Nuvia ALA), then other companies may follow this precedent and try to "free ride" on Arm's licensing regime, causing a loss of control of Arm's licensing ecosystem.[200] In essence, Arm licenses become "tradeable commodities" between companies.[201] Such an occurrence may result in Arm being deprived of the opportunity to partner with new companies in industries and markets that have not yet emerged.[202]

80. Arm negotiates TLAs and ALAs with specific companies and includes many terms specific to those agreements.[203] Arm considers many different factors when negotiating the terms of a specific TLA or ALA and ensures that any final agreements include protections for Arm's intellectual property.[204] In particular, Arm negotiates license agreements for the purpose of the licensee using or developing [redacted] for its own use and compensating Arm for that use.[205] Arm also negotiates its rates based on downstream target markets.[206] Arm does not intend or expect, and Arm licensees do not pay for, the right to acquire and use products developed by other licensees under other license agreements with other technical and financial terms (and that may have been negotiated with different downstream products in mind).[207] In such a situation, the acquiring company taking a lower, unnegotiated for rate, would allow it to gain an unfair advantage over other Arm partners.[208]

81. Accordingly, if a licensee were permitted to "go around" these protections and acquire other licensees (*i.e.*¸ "free ride" on Arm's ecosystem and partners' development) knowing

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[200] Discussions with Will Abbey and Paul Williamson.
[201] Discussions with Paul Williamson.
[202] Discussions with Will Abbey and Paul Williamson.
[203] Discussions with Paul Williamson and Christine Tran.
[204] Discussions with Paul Williamson and Christine Tran.
[205] Discussions with Paul Williamson and Christine Tran.
[206] Discussions with Paul Williamson.
[207] Discussions with Paul Williamson and Christine Tran.
[208] Discussions with Will Abbey and Paul Williamson.

that it could use that other licensees' work and pay their own differently negotiated royalty rates, then the harm to Arm's ecosystem would be significant.[209] Any Arm licensee could consider this an option and, accordingly, all of Arm's existing and prospective licenses would be at risk.[210]

82. This risk is acute even considering only Arm's largest licensees. For example, none of Arm's largest licensees [redacted] But if Qualcomm were permitted to do so, then Arm's other major licensees (and potentially all licensees) would effectively consider themselves to have the same right – or at least the ability to do so based on Qualcomm's example and that Arm could not rely on the protections in its license agreements to prevent these actions.[212] Arm's licensees would effectively be able to commandeer the development of all other Arm licensees, complete development, and then commercialize the other licensees' work under their own agreement – an agreement that does not give them such a right -- and with potentially lower royalty rates.[213]

83. Mr. Abbey identified these risks in his deposition testimony stating that [redacted] Mr. Abbey further testified that [redacted]

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[209] Discussions with Will Abbey and Paul Williamson.
[210] Discussions with Will Abbey and Paul Williamson.
[211] Discussions with Will Abbey and Paul Williamson.
[212] Discussions with Will Abbey and Paul Williamson.
[213] Discussions with Will Abbey and Paul Williamson.
[214] Deposition of Will Abbey, October 27, 2023, p. 361.

[redacted]

84. If Qualcomm could acquire Nuvia, repurpose Nuvia's development work under the ALA for a different purpose, and then commercialize that work under Qualcomm's own lower royalty rates, then Arm would effectively lose control of its intellectual property and licensing ecosystem.[216] Particularly given Qualcomm's size and prominence as one of Arm's largest partners by royalty revenue, there would be little to stop others from engaging in the same actions as Qualcomm knowing that Arm could not enforce the contractual provisions that protect Arm's intellectual property.[217]

85. In my opinion, the scope of the harm of existing and prospective Arm licensees exploiting development and financial terms of other licenses in unexpected ways to compete against Arm's partners cannot be readily determined or quantified and the damages associated with that harm cannot be determined with reasonable certainty. Therefore, monetary damages cannot adequately compensate Arm for this harm.

iii. Arm Will Not Be Able to Rely on Partners Respecting Provisions in Its Existing and Prospective Licenses to Protect Its Intellectual Property

86. The harm to Arm's ability to freely negotiate licensing terms with the expectation that those freely-negotiated licensing terms will be enforced resulting from Defendants' breach of the Nuvia ALA cannot be readily quantified and the associated monetary damages cannot be reasonably ascertained.[218] This "chilling effect" of increased uncertainty may impact the number and types of licenses that Arm can enter into with existing or prospective partners.[219] Further, Arm will lose its control over its [redacted], including the

[215] Deposition of Will Abbey, October 27, 2023, p. 362.
[216] Discussions with Will Abbey and Paul Williamson.
[217] Discussions with Will Abbey and Paul Williamson.
[218] Discussions with Will Abbey and Paul Williamson.
[219] Discussions with Will Abbey and Paul Williamson.

ability to determine which entities have access to such information.[220]

87. Mr. Abbey's testimony highlighted the importance of Arm's ability to maintain control of its intellectual property and confidential information. For example, Mr. Abbey stated that, [redacted] Similarly, Mr. Abbey stated, [redacted]2 Mr. Abbey also emphasized [redacted] Specifically, Mr. Abbey stated that [redacted]

88. In my opinion, the scope of the harm of Arm not being able to rely on partners and prospective partners respecting provisions in its existing and prospective licenses to protect [redacted] cannot be readily determined or quantified and the damages associated with that harm cannot be determined with reasonable certainty. Therefore, monetary damages cannot adequately compensate Arm for this harm.

iv. Third Parties and End Users May Shift to Nuvia-based Cores

89. The harm of third parties and end users shifting to Nuvia-based Cores and products incorporating Nuvia-based Cores as a result of Defendants' breach of the Nuvia ALA cannot be

[220] Discussions with Will Abbey and Paul Williamson.
[221] Deposition of Will Abbey, October 27, 2023, p. 352.
[222] Deposition of Will Abbey, October 27, 2023, p. 360.
[223] Deposition of Will Abbey, October 27, 2023, p. 365.

readily quantified and the associated monetary damages cannot be reasonably ascertained.[224] The impetus for such a shift to these other chips would be that Qualcomm contends that Nuvia-based Cores would be sold and subject to the Qualcomm ALA rates which are lower than the Nuvia ALA rates.[225] Accordingly, Qualcomm may be able to sell Nuvia-based Cores and products incorporating Nuvia-based Cores at a lower price point than it would cost an existing or prospective Arm licensee to develop chips under their own TLA or ALA.[226]

90. Qualcomm has publicly touted the performance of the Nuvia-based Cores. Specifically, Qualcomm recently "invited reporters [] to a special benchmarking session for the" Snapdragon X Elite, which is "[redacted]"[227] At the benchmarking session, the "X Elite dunked on Apple, according to an account from a *WindowsCentral* reporter."[228] Qualcomm has stated that "nine Windows PC makers have signed on to build new machines based on the X Elite platform," namely "Acer, ASUS, Dell [], Hewlett Packard, HONOR, Lenovo, Microsoft Surface, Samsung, and Xiaomi."[229] In addition, a May 2021 IBS semiconductor industry report noted that "[t]he acquisition of NUVIA…is expected to strengthen the competitive position of Qualcomm in the notebook computer market."[230]

91. However, in tandem with the performance increases related to Nuvia-based Cores, Qualcomm intends to benefit from lower royalty rates to Arm (since Qualcomm's license

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[224] Discussions with Will Abbey and Paul Williamson.
[225] Discussions with Will Abbey and Paul Williamson.
[226] Discussions with Will Abbey and Paul Williamson.
[227] https://www.forbes.com/sites/jonmarkman/2023/12/05/qualcomms-x-elite-crushes-apple-arm-holdings-stocks-surge/?sh=5f330d9e7d04; *see also* https://www.pcmag.com/news/qualcomm-snapdragon-x-[redacted]
[228] https://www.forbes.com/sites/jonmarkman/2023/12/05/qualcomms-x-elite-crushes-apple-arm-holdings-stocks-surge/?sh=5f330d9e7d04.
[229] https://www.forbes.com/sites/jonmarkman/2023/12/05/qualcomms-x-elite-crushes-apple-arm-holdings-stocks-surge/?sh=5f330d9e7d04.
[230] ARM_00088045 – 303 at 219.

agreement has lower royalty rates than the Nuvia ALA[231]). As previously discussed in this report, Qualcomm contends that its acquisition of Nuvia allows Qualcomm to avoid paying Arm royalty rates under its TLA or a renewed TLA for Arm's v9 CPUs. Indeed, this "cost savings" benefit has been analyzed by Qualcomm. [redacted] As such, the cost savings arise from the benefit Qualcomm received by commandeering Nuvia's development under a different agreement – the Nuvia ALA.

92. The cost savings sought by Qualcomm due to lower royalty payments to Arm also could have a significant impact on Arm's financial performance. Arm's 2nd Amended F-1 highlighted the risk of this type of action (*i.e.*, major customer electing to develop via an ALA) stating, "[i]f our customers, and particularly one or more key customers from whom we generate a significant portion of our revenues, elect to develop their own processors based on our ISA, the market for our developed processor portfolio would decline, which could have a material adverse effect on our business, results of operations, financial condition and prospects."[235]

93. In my opinion, the scope of the harm of third parties and end users shifting to Nuvia-based Cores and products incorporating Nuvia-based Cores cannot be readily determined

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[231] Deposition of Paul Williamson, November 9, 2023, pp. 43 and 95.
[232] QCARM_3524599 – 500 at 599.
[233] QCARM_3524599 – 500 at 599.
[234] [redacted]
[235] ARM_01259705 – 0105 at 9737.

or quantified and the damages associated with that harm cannot be determined with reasonable certainty. Therefore, monetary damages cannot adequately compensate Arm for this harm.

v. Existing and Prospective Licensees May Shift Away from Arm Chips

94. The harm associated with existing and prospective Arm licensees shifting away from Arm chips altogether as a result of Defendants' breach of the Nuvia ALA cannot be readily quantified and the associated monetary damages cannot be reasonably ascertained.[236] As discussed later in this report, if Arm's investments in research and development were to be impacted due to a decline in revenue, existing and prospective licensees may perceive Arm as not being an industry leader in performance and support.[237] As a result, existing and prospective Arm licensees may seek alternatives to Arm-based and Arm-compatible products and move away from Arm chips.[238]

95. One potential alternative that existing and prospective licensees might consider is RISC-V. RISC-V is described as a different "instruction set architecture," that is open-source.[239] Arm has stated that "[m]any of [its] customers are [] major supporters of the RISC-V architecture and related technologies. If RISC-V-related technology continues to be developed and market support for RISC-V increases, [Arm's] customers may choose to utilize this free, open-source architecture instead of [its] products."[240] While RISC-V has been recognized as a competitive threat, "[t]he general consensus is that, right now, RISC-V doesn't pose a major threat to Arm. That's because the technology is currently far inferior to Arm's offering."[241] The threat of RISC-V is considered to be low because RISC-V is immature compared to Arm and "doesn't have the

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[236] Discussions with Will Abbey and Paul Williamson.
[237] Discussions with Will Abbey and Paul Williamson.
[238] Discussions with Will Abbey and Paul Williamson.
[239] https://www.cnbc.com/2022/09/01/why-arms-lawsuit-against-qualcomm-is-a-big-deal.html.
[240] ARM_01259705 – 0105 at 9733.
[241] https://www.cnbc.com/2023/09/14/arm-ipo-what-is-risc-v-and-why-does-arm-call-the-rival-product-a-risk.html.

same level of support."[242] RISC-V does not have the type of ecosystem that has been developed by Arm.[243] However, the risk of competition from RISC-V may increase as a result of Qualcomm's and Nuvia's alleged actions.[244]

96. The uncertainty introduced by Qualcomm's and Nuvia's alleged actions could result in promotion or increased adoption of RISC-V or x86 despite the perceived current lack of support for the alternative. Such a development could have long-term, unforeseen consequences on Arm's licensing ecosystem.

97. In my opinion, the scope of the harm of existing and prospective Arm licensees shifting away from Arm chips cannot be readily determined or quantified and the damages associated with that harm cannot be determined with reasonable certainty. Therefore, monetary damages cannot adequately compensate Arm for this harm.

vi. Licensing Ecosystem Summary

98. In my opinion, the scope of the harm to Arm's licensing ecosystem caused by Defendants' breach of the ALA cannot be readily determined or quantified and the damages associated with that harm cannot be determined with reasonable certainty. Therefore, monetary damages cannot adequately compensate Arm for this harm.

99. The harms to Arm's licensing ecosystem are substantial and pose a significant threat to Arm's business. The reason for this is that Arm's business revolves around its licensing of [redacted] and if Defendants can breach the Nuvia ALA and continue to use [redacted] provided under

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[242] https://www.cnbc.com/2023/09/14/arm-ipo-what-is-risc-v-and-why-does-arm-call-the-rival-product-a-risk.html.
[243] https://www.cnbc.com/2023/09/14/arm-ipo-what-is-risc-v-and-why-does-arm-call-the-rival-product-a-risk.html.
[244] Discussions with Will Abbey and Paul Williamson.

the Nuvia ALA, and products embodying such technology and information (including the Nuvia-based Cores), then Arm's entire business may be substantially undermined.

C. Significant Negative Impact on Arm's First Mover Advantage

100. The harm to Arm's first mover advantage resulting from Defendants' breach of the Nuvia ALA cannot be readily quantified and the associated monetary damages cannot be reasonably ascertained.[245] Arm's loss of first mover advantage could cause significant detrimental effects, including a loss of ecosystem benefits and the ability of Arm to establish a foothold in emerging markets as potential licensees seek alternatives to Arm-based technology.[246]

101. Due to its early innovation, Arm has established a meaningful presence in the market. As described in its 2nd Amended F-1, Arm states that it has "enjoyed success for more than 30 years by providing market-leading technology, adapting [its] solution to changing market needs and building a software developer ecosystem unlike any other in history."[247] In describing its formation, Arm states that:

> The original joint venture set out to develop a processor that was high performance, power efficient, easy to program, and readily scalable—a goal that continues to define Arm today. Our CPUs initially gained significant traction in mobile phones in the mid-1990s because our energy-efficient processors provided an appropriate level of performance while consuming little power, which was critical for these smaller form factor devices. Over time, mobile phones, and the chips they used, became more advanced and ultimately evolved into the smartphones that are prevalent today. The Arm CPU proved to be critical in enabling the smartphone revolution.[248]

102. Arm's innovation in the mobile phone revolution has been significant. Namely, "[w]ith the help of Arm technology, many more devices such as televisions, watches, washing

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[245] Discussions with Will Abbey and Paul Williamson.
[246] Discussions with Will Abbey and Paul Williamson.
[247] ARM_01259705 – 0105 at 9720.
[248] ARM_01259705 – 0105 at 9714.

machines, cameras, factory equipment, and others are undergoing the same revolution."[249] Indeed, Arm's CPU architecture "has resulted in the proliferation and evolution of computers as people know them today. [By enabling] the mobile phone and smartphone revolution, and through [its] focus on energy efficiency and [its] history of continuous innovation, [Arm has] enabled new categories of 'smart' consumer electronics."[250] In fact, "in the fiscal year ended March 31, 2023, more than 260 companies reported that they had shipped Arm-based chips, and [] approximately 70% of the world's population uses Arm-based products."[251] In addition, "[t]he scale of [Arm's] reach continues to expand, with more than 30 billion Arm-based chips reported as shipped in the fiscal year ended March 31, 2023 alone, representing an approximately 70% increase since the fiscal year ended March 31, 2016."[252] As evidence of Arm's long standing impact on the CPU industry, Arm reports that "based on royalty revenue information provided to us by customers in quarterly royalty reports, approximately 46% of our royalty revenue for the fiscal year ended March 31, 2023 came from products released between 1990 to 2012."[253]

103. Based on its existing ecosystem in markets such as mobile phones and smartphones, Arm has indicated that it intends to expand its presence in new markets. For example, statements in its 2nd Amended F-1 express Arm's intentions to grow its presence, as highlighted below.

- "We have long-standing, significant market share in high-value markets, such as mobile applications processors, which enables us to invest in other growth opportunities. Our long-term growth strategy includes expanding our market share in growth markets, including cloud compute, networking equipment, automotive, and consumer electronics. We believe that the increasing need for high-powered and energy-efficient computing, as well as our continued investments, will enable us to grow our share in these segments."[254]

[249] ARM_01259705 – 0105 at 9714.
[250] ARM_01259705 – 0105 at 9792.
[251] ARM_01259705 – 0105 at 9792.
[252] ARM_01259705 – 0105 at 9792.
[253] ARM_01259705 – 0105 at 9794.
[254] ARM_01259705 – 0105 at 9792 – 793.

- "Arm CPUs are the world's most widely licensed and deployed processors. Our products are used in almost all smartphones, the majority of tablets and digital TVs, and a significant proportion of all chips with embedded processors, including for both consumer and enterprise applications. For the fiscal year ended December 31, 2022, we had a greater than 99% share of the smartphones market and a very high share in a range of other electronic devices, from digital TVs to drones. As new high-growth markets for electronics emerge and incorporate more AI and ML workloads, they require our more advanced processor designs in areas such as cloud computing the automotive industry, and it IoT economy. Our operating and financial performance is dependent, in large part, upon maintaining our market share in the smartphone and consumer electronics markets and maintaining or growing market share in our other target markets."[255]

- "For established markets where there is an incumbent architecture with a supporting ecosystem, it can be difficult for a new architecture to displace existing architectures and, therefore, to gain market share. For example, we have made significant progress and have established a large market share in markets such as smartphones, consumer electronics, and IoT. We face competition primarily from other architectures like x86 and RISC-V in many of these markets. Furthermore, certain semiconductor companies, including some of our existing customers, have designed or are in the process of designing their own architectures in markets such as smartphone application processors, other mobile chips, consumer electronics, IoT and embedded computing, networking equipment, automotive, and cloud compute."[256]

104. As previously discussed in this report, Arm partners with companies of varying size.[257] With "thousands of partners, [Arm's] customers can go to market faster with [] products that customers demand."[258] Arm's licensees and partners comprise a number of companies throughout the supply chain for semiconductor products, including fabrication companies, design companies, and manufacturers of end-user devices.[259] Mr. Segars testified that [redacted]

[255] ARM_01259705 – 0105 at 9795.
[256] ARM_01259705 – 0105 at 9838.
[257] https://www.arm.com/partners.
[258] https://www.arm.com/partners.
[259] Deposition of Paul Williamson, November 9, 2023, pp. 279 – 281.

[redacted] Mr. Herbert similarly testified of the software ecosystem as follows: [redacted]

105. By acquiring Nuvia, Qualcomm gained an advantage by way of an accelerated path to developing its own CPUs, which will come at the expense of Arm's other licensees. As part of the rationale for acquiring Nuvia, Qualcomm stated that [redacted]

> [redacted]

[260] Deposition of Simon Segars, November 16, 2023, p. 32.
[261] Deposition of Tim Herbert, October 25, 2023, pp. 90 – 91.
[262] QCARM_7467691 – 692 at 692.
[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted] Ultimately, via its acquisition of Nuvia, Qualcomm has shortened the time it would have needed to build its own CPU development team as well as the development time itself.

106. As described above, Arm has developed a significant presence—particularly in the mobile segment, which has led to the development of an extensive partner ecosystem. Arm's vast ecosystem also serves to buttress Arm's established presence given the benefits afforded to Arm's

[redacted]

partners and end users. Through its actions, Qualcomm appears intent on leveraging Arm's presence in the market and ecosystem to replace CPUs developed under Arm TLAs with Nuvia-based Cores. As discussed previously in this report, a harm that may result to Arm is third parties and end users shifting to Nuvia-based Cores. By foregoing its own development efforts (and related costs), Qualcomm appears poised to use the Nuvia-based Cores at the direct expense of Arm and its established first mover advantage. This advantage may not have been realized under Qualcomm's own ALA, given that Qualcomm had failed to create its own products under that agreement.[268] In addition to losing the benefit of its first mover advantage in the mobile segment, Qualcomm's actions also jeopardize Arm's ability to use this advantage to enter and grow its presence in emerging markets. [redacted] Here again, as with the mobile segment, Qualcomm intends to benefit from foregoing its own development efforts (and related costs) to use Nuvia-based Cores to the detriment of Arm's own decades-long efforts. With fewer licensees, Arm's ability to broaden into emerging markets will be impacted.

107. In my opinion, the scope of the harm of the significant negative impact on Arm's first mover advantage cannot be readily determined or quantified and the damages associated with that harm cannot be determined with reasonable certainty. Therefore, monetary damages cannot adequately compensate Arm for this harm.

D. Arm's Expansion into New Segments and Markets Will Be Undermined

108. The harm to Arm's expansion into new segments and markets resulting from

[268] Deposition of Richard Grisenthwaite, November 15, 2023, p. 218.
[269] QCARM_3524599 – 500 at 599.

Defendants' breach of the Nuvia ALA cannot be readily quantified and the associated monetary damages cannot be reasonably ascertained.[270] For example, Arm has sought, and is still seeking, to develop a presence in the server market.[271] Nuvia was expected to provide Arm with a foothold in this segment where x86 dominates.[272] However, Qualcomm's actions resulted in the diversion of Nuvia's efforts away from developing a CPU for servers, which have undermined Arm's planned expansion into the segment.

109. As discussed previously in this report, [redacted]

[270] Discussions with Will Abbey and Paul Williamson.
[271] Discussions with Will Abbey and Paul Williamson.
[272] Discussions with Will Abbey and Paul Williamson.
[273] QCARM_3314892 – 915 at 893.
[274] ARM_00002198 – 202 at 198.
[275] ARM_00000045.

[redacted] Upon announcing the acquisition of Nuvia, Qualcomm's January 2021 press release stated that "[t]he addition of NUVIA CPUs to Qualcomm Technologies' already leading mobile graphics processing unit (GPU), AI engine, DSP and dedicated multimedia accelerators will further extend the leadership of Qualcomm Snapdragon platforms, and positions Snapdragon as the preferred platform for the future of connected computing."[278] In its Form 10-K filing, Qualcomm reported that "[u]pon completion of development, NUVIA's technologies are expected to be integrated into certain QCT products."[279]

110. With the loss of Nuvia's focus on developing a data center CPU, Arm experienced a significant setback in its attempt to develop this particular market segment.[280] As described in a December 2020 Gartner industry report:

> General-purpose server processors based on Arm-intellectual property (IP) have long held the promise of delivering energy-efficient solutions for the data center that could compete with the incumbent x86 processors. The Arm IP-based model enables 'low cost' chip development. Over the years many semiconductor vendors and startups have taken this path and developed Arm-based server processors with the intent of disrupting the x86 markets and competing with the incumbent vendor.[281]

111. However, Gartner stated that, "[t]o date, none of these vendors have achieved significant success, and many have had to reevaluate their developments or fallen by the

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[276] QCARM_0584330 – 332 at 332.
[277] QCARM_0584330 – 332 at 331.
[278] https://www.qualcomm.com/news/releases/2021/01/qualcomm-acquire-nuvia.
[279] Qualcomm Inc Form 10-K for the fiscal year ended September 26, 2021, p. F-30.
[280] *e.g.*, [redacted]
[281] ARM_00045266 – 276 at 267.

wayside."[282] Gartner further explained that "[m]ost of these vendors have failed to achieve success with their Arm-based designs due to:

- The lack of per-thread performance for early Arm cores when compared to available x86 processors.
- Immaturity of the vendor ecosystem and software compatibility.
- The operational cost to add additional processor architecture into IT management systems, which was too high for many potential customers.
- The inertia of the IT industry and the data center market, which results in it taking many years for new vendors to displace incumbent vendors."[283]

112. The Gartner report also noted that:

> Despite these new and interesting products [by NVIDIA, Amazon Web Services, and a number of Chinese companies], challenges still remain as vendors have to compete with the incumbent x86 architecture, which has significant investments in both CPU development and software ecosystems.[284]

Gartner further estimated that:

> At the same time, there is growing interest in the use of Arm-based processors within the data center. While previously, Arm has had little impact on the data center (ripples on the x86 mill pond), a growing wave of Arm-based solutions is anticipated.[285]

113. Arm's challenges in the data center segment were also explained in a December 2021 Arm document related to its now-abandoned corporate transaction with NVIDIA. Specifically, the document indicated that:

[redacted]

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[282] ARM_00045266 – 276 at 267.
[283] ARM_00045266 – 276 at 268.
[284] ARM_00045266 – 276 at 268.
[285] ARM_00045266 – 276 at 269.

[redacted]

114. The dominance of Intel's x86 CPUs in the server market is due in part "because they profit from the complete hardware and software ecosystem that is the result of Intel and AMD's long years of developing the market; they also offer incredibly fast response time and excel at tackling complex workloads through multithreading."[287] [redacted]

115. The previously mentioned Arm document also included the following discussion points related to Arm's efforts to significantly penetrate the data center market.

- [redacted]

[286] ARM_00088656 – 684 at 667.
[287] https://www.gigabyte.com/Article/server-processors-the-core-of-a-server-s-performance.
[288] QCARM_3314892 – 915 at 899.
[289] QCARM_3314892 – 915 at 905.
[290] [redacted]

[redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

291 ARM_00088656 – 684 at 667 – 668.
292 ARM_00088656 – 684 at 658.
293 ARM_00088656 – 684 at 658.
294 ARM_00088656 – 684 at 658.
295 ARM_00088656 – 684 at 658.
296 ARM_00088656 – 684 at 659.

[redacted]

[redacted]

116. Despite these headwinds, Arm reiterated its commitment to developing the server market in its 2nd Amended F-1 Registration Statement, stating that the "market[] represent[s] a significant portion of [its] revenue growth opportunity."[299]

117. Arm indicated that not developing the data center market would adversely affect its business, stating that "[i]f any of these markets do not develop as we currently anticipate or we fail to establish ourselves in these new markets, we could suffer a material adverse effect on our competitive position and business prospects."[300] With Qualcomm's acquisition of Nuvia and the abandonment of Nuvia's data center CPU, Arm's statements indicate that its attempt to broaden its toehold in the data center segment is uncertain and/or significantly delayed. This is especially the case as [redacted]

118. In sum, while Arm's ALAs and TLAs (including the Nuvia agreements) do not require development in a particular industry or market segment, Arm's execution of them and the specific terms agreed to can be influenced at least in part by Arm's expectation that the licensee will help it gain a foothold in a new industry or market segment, as was the case with Nuvia.[302]

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[297] ARM_00088656 – 684 at 661.
[298] ARM_00088656 – 684 at 661.
[299] ARM_01259705 – 0105 at 9738.
[300] ARM_01259705 – 0105 at 9738.
[301] Deposition of Simon Segars, November 16, 2023, pp. 79 – 80.
[302] Discussions with Will Abbey and Paul Williamson.

119. In my opinion, the scope of the harm of undermining Arm's expansion into new segments and markets cannot be readily determined or quantified and the damages associated with that harm cannot be determined with reasonable certainty. Therefore, monetary damages cannot adequately compensate Arm for this harm.

E. Significant Decrease in Licensing Revenue and Arm's Investment in Research and Development

120. The significant decrease in Arm's revenue and investment in research and development ("R&D") and innovation resulting in the loss of control of Arm's intellectual property stemming from Defendants' breach of the Nuvia ALA cannot be readily quantified and the associated monetary damages cannot be reasonably ascertained.[303]

121. Arm's loss of control of its intellectual property and licensing ecosystem, as described above, is likely to result in decreased licensing revenue which, in turn, would result in decreased investment in R&D, which will harm Arm's ability to improve its technology going forward in detrimental ways that cannot be readily quantified with reasonable certainty.[304]

122. Arm's innovations are reliant on its R&D investments. Arm states that "[r]esearch and development is at the heart of [its] business and critical to [its] future success. Accordingly, [it has] always invested, and will continue to invest, significant resources in [its] R&D program. [Arm's] vision to invest and develop new products is driven by [its] desire to maintain or increase [its] market share and create value for [its] customers."[305] Mr. Williamson's testimony highlights Arm's drive to develop and innovate, stating that [redacted]

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[303] Discussions with Paul Williamson.
[304] Discussions with Paul Williamson.
[305] ARM_01259705 – 0105 at 9804.

[redacted]

123. Arm describes its R&D expenses as follows:

> R&D expenses consist primarily of employee-related expenses, including salaries, bonuses, share-based compensation, and benefits associated with employees in research and development functions, along with project materials costs, third-party fees paid to consultants, depreciation and amortization, allocated overhead, information technology and other development expenses.[307]

124. Arm describes itself as "an engineering-first company, with 4,753 of [its] employees, or approximately 80% of [its] global employees, as of March 31, 2023, focused on research, design, and technical innovation."[308] As shown in the figure below, [redacted]

125. The importance of Arm's R&D investment to its future success is underscored in its 2nd Amended F-1 filing, as shown below.

- "We will have to make significant expenditures to continue developing our semiconductor products and other products. The long development time of generally five or more years from the initial design of our semiconductor products until its incorporation into new end-user applications can place significant strain on our financial resources and personnel."[310]

[306] Deposition of Paul Williamson, November 9, 2023, p. 227.
[307] ARM_01259705 – 0105 at 9804 – 805.
[308] ARM_01259705 – 0105 at 9721.
[309] ARM_00000510 – 632 at 535; ARM_00000382 – 509 at 416; ARM_00000244 – 381 at 281; https://www.currency.me.uk/convert/gbp/usd.
[310] ARM_01259705 – 0105 at 9739.

- "To remain competitive, we must continue to develop new products, applications; and enhancements to our existing products and services, particularly as next generation technology is adopted by market participants. Allocating and maintaining adequate research and development resources, such as the appropriate personnel and development technology, to meet the evolving demands of the market is essential to our continued success...."[311]

- "We have substantially increased our R&D investment to focus on long-term returns and to replicate the strong position that we maintain in smartphones and in other markets, such as automotive, networking equipment, cloud compute and industrial IoT. Each generation of processor is typically more advanced and more complex than the previous generation, which requires increased development efforts that may be partially offset by improvements in productivity. Consequently, each year we increase our R&D investment in line with the increased development needs of the next generation of products."[312]

126. However, Arm's R&D investments are at risk based on Qualcomm's and Nuvia's failure to adhere to the Nuvia ALA.

127. Arm's R&D investments are tied to its revenue stream. As such, any significant changes to Arm's expected revenues can impact Arm's future R&D activities, which in turn can lead to a further decline in revenue. Mr. Segars testified that [redacted] This relationship between revenue and R&D is illustrated in Arm's documents, as shown below.

- "Our customers may decide to license our ISA and develop their own processors based on our ISA, rather than utilize our predeveloped products through an implementation license, resulting in less fees paid to us. Customers may choose to develop their own processors if they believe they can do so more effectively than us or if supply and capacity constraints within the semiconductor industry further incentivize vertical

[311] ARM_01259705 – 0105 at 9745.
[312] ARM_01259705 – 0105 at 9804.
[313] Deposition of Simon Segars, November 16, 2023, p. 192.

integration in an effort to secure additional control over their supply chains."[314]

- "If our customers, and particularly one or more key customers from whom we generate a significant portion of our total revenues, elect to develop their own processors based on our ISA, the market for our developed processor portfolio would decline, which could have a material adverse effect on our business, results of operations, financial condition and prospects."[315]

- "Additionally, certain of our customers have in the past sought, and customers may in the future seek, to renegotiate pre-existing contractual commitments. [] [S]ignificant reductions in existing contractual commitments could have a material adverse effect on our financial condition and results of operations."[316]

- "Our ability to fund research and development expenditures depends on generating sufficient revenue and cash flows from operations and the availability of external financing, if necessary. Our research and development expenditures, together with other ongoing operating expenses, is a substantial drain on cash flow and may decrease cash balances, which may limit our ability to pursue other potentially attractive initiatives."[317]

- [redacted]

- [redacted]

[314] ARM_01259705 – 0105 at 9737.
[315] ARM_01259705 – 0105 at 9737.
[316] ARM_01259705 – 0105 at 9744.
[317] ARM_01259705 – 0105 at 9744.
[318] ARM_00088656 – 684 at 663.

[redacted]

128. As discussed above, Arm's R&D investments are the heart of its business and critical to its future success. Arm's significant levels of R&D are based on its licensing revenue. However, as previously discussed in this report, [redacted] The cost savings to Qualcomm are revenue losses to Arm. Additionally, as discussed previously in this report, other existing and prospective licensees may seek alternatives to Arm, resulting in decreased revenues to Arm. As such, the potential loss of revenue from (1) Qualcomm's and Nuvia's alleged breach and (2) the resulting decrease in revenue from other partners over time will have a compounding effect on Arm in the future if it is unable to continue its R&D activities at a level necessary to remain competitive. In other words, as Mr. Segars testified [redacted] This loss is not quantifiable.

129. In my opinion, the scope of the harm associated with the significant decrease in licensing revenue and Arm's investment in research and development cannot be readily determined or quantified and the damages associated with that harm cannot be determined with reasonable certainty. Therefore, monetary damages cannot adequately compensate Arm for this harm.

F. Significant Decrease in Arm's Reputation and Goodwill

130. The harm to Arm's reputation and decrease in Arm's goodwill resulting from

[319] ARM_00088656 – 684 at 663.
[320] [redacted]

Defendants' breach of the Nuvia ALA cannot be readily quantified and the associated monetary damages cannot be reasonably ascertained.[321]

131. Arm's brand and reputation are critical aspects of its success. As discussed above, Arm's history of innovation has resulted in significant success and presence in the market, particularly in the mobile segment. Arm's 2nd Amended F-1 filing states that its "brand and reputation are critical factors in [its] relationships with customers, employees, governments, suppliers, and other stakeholders. [Its] failure to address, or the appearance of [its] failure to address, issues that give rise to reputational risk…could significantly harm [Arm's] brand and reputation."[322] Qualcomm's and Nuvia's actions, and their ability to avoid the requested specific performance may have a detrimental impact on Arm's goodwill through harm to its brand and reputation.

132. Mr. Williamson discussed the harm to Arm's goodwill stating that [redacted][3] Mr. Williamson also testified that [redacted] Similarly, Mr. Williamson testified that [redacted]

[321] Discussions with Paul Williamson.
[322] ARM_01259705 – 0105 at 9758.
[323] Deposition of Paul Williamson, November 9, 2023, p. 243 (emphasis added).
[324] Deposition of Paul Williamson, November 9, 2023, p. 246.

[redacted] Finally, Mr. Williamson stated that [redacted]

133. Mr. Abbey also testified regarding harm to Arm's brand (and thus goodwill), stating that [redacted] Mr. Abbey also stated that [redacted] Further, Mr. Abbey testified that [redacted]

134. Harm to Arm's brand and reputation can be wide ranging. Arm has stated that:

> Damage to [its] brand and reputation could reduce demand for [its] products and adversely affect [its] business, operating environment and the trading price of [its] securities. Damage to [its] reputation may also make us less attractive to current and prospective employees relative to [its] competitors, particularly given the intensely competitive market for highly skilled employees. Moreover, repairing [Arm's] brand and reputation may be difficult, time-consuming, and expensive. The heightened competitive pressures could result in a loss of customers or a reduction in revenues or revenue growth rates, all of which could

[325] Deposition of Paul Williamson, November 9, 2023, p. 246.
[326] Deposition of Paul Williamson, November 9, 2023, p. 248.
[327] Deposition of Will Abbey, October 27, 2023, p. 324.
[328] Deposition of Will Abbey, October 27, 2023, p. 361.
[329] Deposition of Will Abbey, October 27, 2023, p. 361.

> adversely affect [its] business, results of operations, financial condition and prospects.[330]

135. As illustrated above and through this report, Arm's goodwill and reputation are critical to its success and market standing. Arm's brand as an innovator has been built over many decades. This includes harm to Arm's reputation due to a lessened perception in the enforceability of contractual terms, and potential increased need by Arm to enforce those terms through litigation. Harm to Arm's goodwill and reputation cannot be measured as a result of Qualcomm's and Nuvia's alleged actions.

136. In my opinion, the scope of the harm associated with the significant damage to Arm's reputation and goodwill cannot be readily determined or quantified and the damages associated with that harm cannot be determined with reasonable certainty. Therefore, monetary damages cannot adequately compensate Arm for this harm.

G. Inadequacy of Damages Exacerbated by Several Additional Factors

137. Several additional factors in this case exacerbate the potential harms to Arm, and the uncertainty of monetary damages adequate to compensate for those harms, if Defendants are found liable for breaching the Nuvia ALA but are not required to discontinue use and distribution of [redacted], and any products embodying such technology or information (including Nuvia-based Cores).

138. For example, [redacted] Qualcomm made up [redacted] of Arm's total revenue for the fiscal year ended March 30, 2023.[332] Given the magnitude of Qualcomm's contribution to Arm's financial performance (as well as Qualcomm's overall status in the industry), Qualcomm's

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330 ARM_01259705 – 0105 at 9758.
331 Deposition of Rene Haas, December 12, 2023, p. 107.
332 ARM_01259705 – 0105 at 9754; *See also* Deposition of Simon Segars, November 16, 2023, pp. 10 – 13.

alleged actions would have an outsized impact on Arm. To the extent Qualcomm is permitted to use the Nuvia-based Cores developed under the Nuvia ALA, other industry participants (and Arm licensees) may be emboldened given Qualcomm's size as an Arm licensee and recognition as an industry leader.

139. Another exacerbating factor is the relative speed with which the CPU industry develops. Emerging technologies develop rapidly and may not be foreseen.[333] Arm asserts that it is "continuously evaluating emerging markets and technologies that may enable [it] to create more advanced products that bring more value to [it]s customers and ecosystem."[334] For example, Arm states that it is "leading the way in integrating AI and ML capabilities across all devices through [its] highly scalable architecture. All modern smartphones are AI and ML capable by virtue of their Arm processors, and we are increasingly working with companies in other markets, such as consumer electronics and automotive, to deploy AI-based solutions."[335] However, Arm has stated that "[i]f it fail[s] to develop new products in response to, or in anticipation of, rapid technological changes in [its] industry or the industries [it] serve[s], [its] business may be materially and adversely affected."[336] Further, Arm has indicated that both known and unknown rapid technological changes make "the future market for [its] products [] difficult to predict."[337] Given the rapidly evolving landscape of electronics (which cannot be fully anticipated), the total harm to Arm is unpredictable. For example, as previously discussed, Arm gained a first mover advantage in the mobile CPU segment, but Arm's ability to leverage this advantage to emerging markets could be in jeopardy due to Qualcomm's and Nuvia's alleged

[333] Discussions with Will Abbey and Paul Williamson.
[334] ARM_01259705 – 0105 at 9722
[335] ARM_01259705 – 0105 at 9722.
[336] ARM_01259705 – 0105 at 9724.
[337] ARM_01259705 – 0105 at 9739.

actions. This sort of impact is amplified by the so-called "Butterfly Effect."[338] In other words, future triggering events could magnify the potential impacts of Qualcomm's and Nuvia's alleged actions (discussed previously in this report) and may set into motion events that may be different (potentially significant) in the "but for" scenario in which Qualcomm and Nuvia act within the bounds of its agreements as sought by Arm. For example, an event in the server market that significantly increases demand of server CPUs would have an even larger impact on Arm given Arm's small market presence in that space and its delayed development of the segment due to Nuvia's shift away from developing what was a promising alternative to x86-based processors. Or in another example, a decrease in Arm's R&D activities (as previously discussed) could result in its inability to capitalize on currently unforeseen CPU applications.

140. The uncertainty of the harms discussed in this report are particularly acute given that they involve the actions of parties (*i.e.*, current and prospective licensees), unknown emerging market segments, among other uncertainties. Such factors include but are not limited to the following.

- The ability to quantify the number prospective licensees and related revenue is not ascertainable.
- The difficulty in measuring the financial impact of actions that current and prospective licensees may take based on the decisions of other licensees.
- The ability to measure the goodwill and reputational harm due to Qualcomm's and Nuvia's alleged actions would be difficult.
- The uniqueness of Qualcomm as a market leader (and one of Arm's largest customers) which would have an outsize impact on its alleged breach.
- The value of Arm's first mover advantage in emerging markets and the magnitude of the loss is difficult to measure.

[338] https://www.forbes.com/sites/startswithabang/2018/02/13/chaos-theory-the-butterfly-effect-and-the-computer-glitch-that-started-it-all/?sh=4b460bee69f6; https://hbr.org/2022/08/in-uncertain-times-the-best-strategy-is-adaptability.

- The loss of revenue from the factors discussed in this report would have an unpredictable impact on Arm's total financial condition and market presence.

VIII. TRADEMARK INFRINGEMENT

141. I am informed and understand that Arm seeks a declaratory judgment that Defendants unlicensed use of Arm's trademarks will constitute trademark infringement.[339] I am informed and understand that Arm is not aware of any trademark infringements by Defendants to date.[340] I may be asked to opine on potential damages associated with trademark infringement if any such infringement is alleged to have occurred before trial of this matter. I reserve my right to do so.

IX. OTHER ISSUES

142. This report represents my analysis, opinions, and conclusions at this time and is based on information available to me as of the date above. The citations listed in this report are illustrative, and as part of my analysis, I also considered the additional documents and other information listed on Schedule 2. If additional information or testimony becomes available to me, I may revise or supplement my analysis, opinions, and conclusions, and I may modify or supplement my report as necessary. I may testify at trial regarding any related matter raised by the parties after the date of this report if asked to do so by the Court or the parties' attorneys. I may be asked to develop additional schedules or exhibits for trial purposes related to my analysis, opinions, and conclusions. I may also be asked to develop and rely on demonstratives at trial or any pre-trial proceeding. I may also be asked to develop additional schedules or exhibits if asked to do so by the Court or the parties' attorneys, post-trial. This report is intended solely for use in

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[339] Complaint, August 31, 2022, pp. 18 – 22.
[340] Arm Ltd.'s Second Supplemental Objections and Responses to Qualcomm's First Set of Interrogatories Nos. 1 – 11, November 17, 2023, pp. 17 – 26.

the above-referenced litigation and is not to be used for any other purpose.

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Schedule 1

W. Todd Schoettelkotte, CPA, CVA

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Certifications
Certified Public Accountant, Texas
Certified Valuation Analyst

Professional Affiliations
State Bar of Texas' Grievance Committee, Committee Member, 2004 – 2009

Federal Bar Association, South Texas Chapter, Treasurer, 2007 – 2015

Institution for Law and Technology Advisory Board Member

Associations
American Institute of Certified Public Accountants

Texas Society of Certified Public Accountants

Licensing Executives Society

National Association of Certified Valuators and Analysts

Education
Master of Accounting
Rice University, Houston, TX

BS Management
Rice University, Houston, TX

W. Todd Schoettelkotte is a Senior Managing Director of Ocean Tomo, a part of J.S. Held LLC, a global consulting firm providing specialized technical, scientific, financial, and advisory services. Mr. Schoettelkotte has more than 25 years of experience in the evaluation and quantification of economic damages arising from patent, copyright and trademark infringement, and trade secret misappropriation disputes. His clients have included numerous Fortune 500 companies in a wide variety of industries including semiconductor, telecommunication, energy, consumer products, life sciences and computers (hardware, software and the internet). Mr. Schoettelkotte has been recognized by Intellectual Asset Management Magazine as one of the leading patent damages experts in the United States. Mr. Schoettelkotte's background is in accounting, finance and economics, and he has a specific, focused understanding of those issues integral to the valuation and management of intellectual property.

Intellectual Property Valuation

Mr. Schoettelkotte has directed numerous valuation projects related to patents, trademarks and trade secrets. A significant portion of his practice is focused on the determination of royalty rates and terms for licensing agreements. Additionally, Mr. Schoettelkotte has conducted numerous studies involving lost profits and unjust enrichment.

In the process of assisting clients in the valuation of intellectual property assets, Mr. Schoettelkotte has participated in the identification and review of business plans, market studies, financial documents and other related information.

Patent, Copyright and Trademark Infringement

Mr. Schoettelkotte has performed market analyses/studies wherein the patented, trademarked or copyrighted product is sold, assessed lost profits stemming from alleged infringements, evaluated the contribution of the patented process/method to the end product and established the economic value of the underlying intellectual property.

Mr. Schoettelkotte is skilled in the application of the Georgia-Pacific factors to the determination of reasonable royalty rates. He has determined reasonable royalty rates within infringement suits on many occasions in numerous industries. Over the course of his career, Mr. Schoettelkotte has reviewed hundreds of license agreements, providing a broad frame of reference for reasonable royalty damages analyses. Mr. Schoettelkotte has testified in federal and state court and arbitration proceedings on matters involving intellectual property valuation, lost profits, reasonable royalty and economic damages issues.

Articles and Presentations

"Intellectual Property Damages," Chicago-Kent College of Law, October 15, 2019

"Damages in Other Areas of Intellectual Property," The University of Arizona IP Conference, March 5, 2018

"Impact of Recent Court Cases on 'Real World' Royalty Rates," LES (USA & Canada) Houston Chapter, July 20, 2017

"What is Discoverable and Admissible for Damages, Willfulness and Other Purposes," Intellectual Property Owners Association, March 21, 2011

"Strategies in Intellectual Property," Chicago Kent, College of Law, Spring 2004 – 2010

Damages, Part II: "Litigation Strategies" – 15th Annual Advanced Patent Law Institute - University of Texas School of Law, October 28-29, 2010

"IP Damages and Valuation," Global Intellectual Property Management, Georgetown University Law Center, July 2, 2008

"Keys for Effectively Working with Your Damages Expert Throughout the Litigation Life Cycle," Houston Bar Association, March 22, 2007

"Advanced Evidence and Discovery – Working With Experts From Start To Finish" – Texas Bar Association, April-May 2006

"Trademarks – Financial Disclosure and Corporate Governance" – International Trademark Association, Emerging Issues in Trademark Law Forum, February 2-3, 2006

"Valuation of IP – A Licensing Perspective" – Lighthouse Seminar Group, IP Licensing Nuts & Bolts, March 3, 2005

"Measuring the Value of Damages in Trademark Infringement Claims" – DuPont's 18th Annual CLE Intellectual Property Law Seminar, October 12, 2004

"Measuring the Value of Damages in Patent and Trademark Claims" – Houston CPA Society, September 2004

"Measuring Damages in Trademark Infringement and Related Claims in Light of Recent Court Decisions" – The 19th Annual Intellectual Property Law Conference – American Bar Association, April 1, 2004

"Intellectual Property Damages: Patents & Trademarks" – Houston CPA Society "Litigation and Valuation Services Committee," January 28, 2004

Co-Author: "Accounting for Attorneys" – University of Oregon School of Law, November 12, 2003

"What are the Financial Stakes in Litigation? What are the Costs and the Return on Investment (ROI) That Can Be Expected? The Question of Intangible Returns?" – 2003 Fourth International Conference on Intellectual Property by CNCPI, October 7, 2003, Paris, France

"Current Issues in the Analysis of Reasonable Royalties in Patent Infringement Actions" – 2003 Licensing Executives Society Annual Meeting, September 24, 2003

Co-Author FTI Consulting Training Course: "Calculating Damages in Patent Infringement – A Lost Profits and Reasonable Royalty Case Study," July 17, 2003

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W. Todd Schoettelkotte
Four Year List of Testimony
As of December 2023

CASE DESCRIPTION / TYPE OF TESTIMONY
In the Matter of Certain Semiconductor Devices, and Methods of Manufacturing Same and Products Containing the Same (Respondents-Innoscience); U.S. International Trade Commission, Washington, D.C., Expert Report, Deposition
Demaray LLC v. Samsung Electronics Co. Ltd., et al.: U.S. District Court, Western District of Texas (Waco), Rebuttal Expert Report, Deposition, Supplemental Report, Deposition
Persawvere, Inc. v. Milwaukee Electric Tool, Corporation; U.S. District Court, District of Delaware (Wilmington), Rebuttal Expert Report, Deposition, Trial
Beacon Navigation GmbH v. Bayerische Motoren Werke AG; BMW of North America, LLC and BMW Manufacturing Co., LLC; U.S. District Court, Southern District of Michigan, Expert Report, Deposition
Ningde Amperex Technology Limited v. Zhuhai CosMX Battery Co., Ltd., et al.; U.S. District Court, Eastern District of Texas (Marshall), Initial Report, Rebuttal Expert Report, Deposition
Plastipak Packaging, Inc. v. Nestlé Waters North America, Inc.; U.S. District Court, Eastern District of Virginia (Alexandria), Opening Expert Report, Rebuttal Expert Report, Supplemental Expert Report, Supplemental Rebuttal Expert Report, Deposition
Ollnova Technologies Limited v. ecobee Technologies, ULC d/b/a Ecobee; U.S. District Court, Eastern District of Texas (Marshall), Rebuttal Expert Report, Deposition, Trial
EIS, Inc. v. IntiHealth GER GmbH, et al.; U.S. District Court, District of Delaware, Expert Report, Rebuttal Expert Report, Commercial Success Report, Reply Report, Trial
HID Global Corporation v. Vector Flow., et al.; U.S. District Court, District of Delaware (Wilmington), Expert Report, Reply Report, Deposition
BlueRadios, Inc. v. Kopin Corporation, Inc.; U.S. District Court, District of Colorado (Denver), Rebuttal Expert Report, Deposition, Supplemental Rebuttal Expert Report, Deposition
Bay Materials, LLC v. 3M Company; U.S. District Court, District of Delaware (Wilmington), Declaration, Deposition, Commercial Success Report, Deposition
Continuous Composites, Inc. v. Markforged, Inc.; U.S. District Court, District of Delaware, Expert Report, Reply Report, Deposition
Fate Therapeutics, Inc., et al. v. Shoreline Biosciences, Inc., et al.; U.S. District Court, Southern District of California (San Diego), Rebuttal Expert Report, Deposition
Delta Air Lines, Inc. v. Marriott International, Inc.; U.S. District Court, Northern District of Georgia (Atlanta), Rebuttal Expert Report, Supplemental Rebuttal Report, Deposition

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Four Year List of Testimony
As of December 2023

CASE DESCRIPTION / TYPE OF TESTIMONY
Textron Innovations Inc. v. SZ DJI Technology Co., Ltd., et al.; U.S. District Court, Western District of Texas (Waco), Expert Report, Deposition, Supplemental Expert Report, Trial
VoIP-Pal.com, Inc. v. Verizon Communications Inc., et al.; U.S. District Court, Western District of Texas (Waco), Rebuttal Expert Report, Deposition
Ragnarok Game, LLC and ESDFOS, LLC v. ZeniMax Media Inc, et al.; Superior Court of the State of California, County of Los Angeles, Central District, Opening Expert Report, Rebuttal Expert Report, Deposition
DivX, LLC v. Harman International Industries, Inc.; New York Supreme Court, New York County, Expert Report, Rebuttal Expert Report, Deposition
Shimon Maimon v. Lockheed Martin Corporation; Judicial Arbitration and Mediation Services, Rebuttal Expert Report, Deposition, Arbitration
WSOU Investments, LLC d/b/a Brazos Licensing and Development v. ZTE Corporation; U.S. District Court, Western District of Texas (Waco), Rebuttal Expert Report, Deposition
Wonderland Switzerland AG v. Evenflo Company, Inc.; U.S. District Court, District of Delaware (Wilmington), Expert Report, Reply Report, Deposition, Supplemental Expert Report, Trial
NNCrystal US Corporation and The Board of Trustees of The University of Arkansas v. Nanosys, Inc.; U.S. District Court, District of Delaware, Expert Report, Reply Report, Deposition
Pavemetrics Systems, Inc. v. Tetra Tech, Inc. and Tetra Tech Tas Inc.; U.S. District Court, Central District of California (Los Angeles), Expert Report, Deposition, Trial
Global Tubing, LLC v. Tenaris Coiled Tubes, LLC and Tenaris, S.A.; U.S. District Court, Southern District of Texas (Houston), Expert Report, Deposition
The Cookie Department, Inc. v. The Hershey Company, One Brands, LLC; U.S. District Court, Northern District of California (Oakland), Rebuttal Expert Report, Deposition
Unirac, Inc. v. EcoFasten Solar, LLC and Esdec, Inc.; U.S. District Court, District of Delaware, Expert Reports, Deposition
In the Matter of Certain Integrated Circuits, Chipsets, and Electronic Devices, and Products Containing the Same (Respondents); U.S. International Trade Commission, Washington, D.C., Rebuttal Expert Report, Deposition

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W. Todd Schoettelkotte
Four Year List of Testimony
As of December 2023

CASE DESCRIPTION / TYPE OF TESTIMONY
In the Matter of Certain High-Density Fiber Optic Equipment and Components Thereof (Complainant); U.S. International Trade Commission, Washington, D.C., Expert Report, Deposition, Witness Statement, Hearing; Enforcement Proceeding - Expert Report, Supplement to the Expert Report, Deposition, 2nd Supplement to the Expert Report, 3rd Supplement to the Expert Report, Witness Statement, 4th Supplement to the Expert Report, Supplement to Witness Statement, Hearing
Blue Mountain Holdings, Ltd., et al. v. Bliss Nutraceticals LLC, et al.; U.S. District Court, Northern District of Georgia (Atlanta), Expert Report, Deposition
Gibson Brands, Inc. v. Armadillo Distribution Enterprises, Inc. and Concordia Investment Partners, LLC; U.S. District Court, Eastern District of Texas (Sherman), Rebuttal Expert Report, Deposition, Supplemental Rebuttal Expert Report, Trial
Conformis, Inc. v. Medacta USA, Inc. and Medacta International SA; U.S. District Court, District of Delaware, Rebuttal Expert Report, Supplemental Rebuttal Expert Report, Deposition
In the Matter of Certain Silicon Photovoltaic Cells and Modules with Nanostructures, and Products Containing Same (Respondents); U.S. International Trade Commission (Washington, D.C.), Expert Report, Deposition, Witness Statement, Hearing
EcoFactor, Inc. v. Google LLC; U.S. District Court, Western District of Texas (Waco), Expert Report, Deposition, Supplemental Report, Trial, Declaration
G.W. Lisk Company, Inc. v. GITS Manufacturing Company; U.S. District Court, Southern District of Iowa (Central); Expert Report, Reply Report, Deposition
American Eagle Outfitters, Inc. and Retail Royalty Company v. Walmart, Inc.; U.S. District Court, Western District of Pennsylvania (Pittsburgh), Expert Report, Rebuttal Report, Deposition
Simply Wireless, Inc. v. T-Mobile US, Inc., et al.; U.S. District Court, Eastern District of Virginia (Alexandria), Expert Report, Reply Report, Deposition, Sur-Sur Reply Report
Gentex Corporation v. Galvion LTD and Galvion Inc.; U.S. District Court, District of Delaware (Wilmington), Expert Report, Reply Report, Deposition
Kirsch Research and Development, LLC v. DuPont de Nemours, Inc., FT Synthetics, Inc. and Atlas Roofing Corporation; U.S. District Court, Eastern District of Texas (Texarkana), Expert Report, Deposition
Malvern PanAnalytical Inc. v. TA Instruments-Waters LLC and Waters Technologies Corporation; U.S. District Court, District of Delaware (Wilmington), Expert Report, Rebuttal Report, Reply Report, Deposition
Finalrod IP, LLC v. Endurance Lift Solutions, Inc.; U.S. District Court, Eastern District of Texas (Marshall), Expert Report, Deposition
Pierce Manufacturing, Inc. and Oshkosh Corporation v. E-One, Inc. and REV Group, Inc.; U.S. District Court, Middle District of Florida (Tampa), Declaration, Expert Report, Deposition, Trial

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As of December 2023

CASE DESCRIPTION / TYPE OF TESTIMONY
Polar Electro Oy v. Suunto Oy, et al.; U.S. District Court, District of Utah (Central), Expert Report, Deposition
Wonderland Switzerland AG v. Evenflo Company, Inc., et al.; U.S. District Court, District of Delaware (Wilmington), Expert Report, Reply Report, Deposition, Trial
Lufkin Industries, Inc. v. International Business Machines Corporation, et al.; 159th Judicial District Court of Angelina County, Texas, Expert Report #1, Supplemental Report #1, Expert Report #2, Supplemental Report #2, Deposition
The Hillman Group, Inc. v. KeyMe, LLC; U.S. District Court, Eastern District of Texas (Marshall), Expert Report, Deposition #1, Consolidated Report, Deposition #2
Team Worldwide Corporation v. Academy, LTD d/b/a Academy Sports + Outdoors, et al.; U.S. District Court, Eastern District of Texas (Marshall), Expert Report, Rebuttal Report, Deposition #1, Deposition #2, Supplemental Report
Nevro Corp. v. Boston Scientific Corporation, et al.; U.S. District Court, Northern District of California (San Francisco), Expert Report, Supplemental Report, Deposition, Declaration
Carnegie Institution of Washington, et al. v. Pure Grown Diamonds, Inc., et al.; U.S. District Court, Southern District of New York (Foley Square), Expert Report, Supplemental Report, Deposition
In the Matter of Certain High-Density Fiber Optic Equipment and Components Thereof (Complainant); U.S. International Trade Commission, Washington, D.C., Expert Report, Deposition, Witness Statement, Hearing
Nissei ASB Co. and Nissei ASB Machine, Co., LTD. v. R&D Tool & Engineering Co.; U.S. District Court, Western District of Missouri (Western), Expert Report, Reply Report, Deposition
Jager Pro Incorporated v. Bull Creek Welding and Fabrication, Inc.; U.S. District Court, Eastern District of Arkansas (Central), Expert Report, Deposition
CFA Institute v. American Society of Pension Professionals & Actuaries, et al.; U.S. District Court, Western District of Virginia (Charlottesville), Expert Report, Deposition
Legacy Separators, LLC, et al. v. Halliburton Energy Services, Inc., et al.; U.S. District Court, Southern District of Texas (Houston), Expert Report, Rebuttal Report, Deposition, Supplemental Report, Second Supplemental Report, Deposition #2, Trial
Saracen LLC, Saracen Energy Power Advisors LP, Saracen Energy Advisors LP, collectively d/b/a The Saracen Group of Companies v. Sylvain Ross and Marginal Unit, Inc.; U.S. District Court, Southern District of Texas (Houston), Expert Report, Supplemental Report, Second Supplemental Report, Third Supplemental Report, Revised Third Supplemental Report, Trial
Innovation Sciences, LLC v. HTC Corporation; U.S. District Court, Eastern District of Texas (Sherman), Expert Report, Deposition
In the Matter of Certain Digital Video Receivers, Broadband Gateways, and Related Hardware and Software Components (Respondents); U.S. International Trade Commission, Washington, D.C., Expert Report, Deposition, Hearing

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Four Year List of Testimony
As of December 2023

CASE DESCRIPTION / TYPE OF TESTIMONY
Under Armour, Inc. v. Battle Fashions, Inc. and Kelsey Battle; U.S. District Court, Eastern District of North Carolina (Western), Expert Report, Deposition, Supplemental Report
Finalrod IP, LLC and R2R and D, LLC d/b/a Superod v. John Crane, Inc., et al.; U.S. District Court, Western District of Texas (Midland), Expert Report, Rebuttal Report, Supplemental Report, Deposition
In the Matter of Certain Wireless Mesh Networking Products and Related Components Thereof (Complainant); U.S. International Trade Commission, Washington, D.C., Expert Report, Deposition, Witness Statement, Hearing
Liqwd, Inc. and Olaplex LLC v. L'Oréal USA, Inc., et al.; U.S. District Court, District of Delaware (Wilmington), Declaration, Deposition #1, Supplemental Declaration, Deposition #2, Expert Report, Deposition #3, Trial
Nevro Corp. v. Stimwave Technologies, Inc.; U.S. District Court, District of Delaware (Wilmington), Declaration, Deposition, Reply Declaration
XY, LLC v. Trans Ova Genetics, LC; U.S. District Court, District of Colorado (Denver), Expert Report, Deposition, Trial, Declaration
Maui Jim, Inc. v. SmartBuy Guru Enterprises, et al.; U.S. District Court, Northern District of Illinois (Eastern), Expert Report, Deposition
MPEG LA, L.L.C. v. Toshiba America Information Systems, Inc.; Supreme Court of the State of New York, County of New York, Expert Report, Deposition
Team Worldwide Corp. v. Intex Recreation Corp, et al.; Federal Arbitration, Inc., Hearing
Justice Laub and Daniel Kanes v. Nicholas Horbaczewski, Drone Racing League, Inc., et al.; U.S. District Court, Central District of California (Western), Expert Report, Deposition
ASM Holding B.V. v. Hitachi Kokusai Electric, Inc.; International Centre for Dispute Resolution, Hearing
Power Integrations, Inc. v. Fairchild Semiconductor International, Inc., et al.; U.S. District Court, District of Delaware (Wilmington), Expert Report, Deposition, Supplemental Report, Trial, Declaration

Arm Ltd. v. Qualcomm, Inc., Qualcomm Technologies, Inc. and Nuvia, Inc.
Documents and Other Information Considered

Schedule 2

ARM_		ARM_		ARM_		ARM_		ARM_		ARM_	
Begin	**End**	**Begin**	**End**	**Begin**	**End**	**Begin**	**End**	**Begin**	**End**	**Begin**	**End**
00000003	00000003	00060458	00060512	01228027	01228027	01235148	01235148	01239454	01239457	01240470	01240507
00000019	00000021	00063692	00063693	01228028	01228028	01235149	01235149	01239458	01239458	01240508	01240526
00000022	00000023	00067288	00067289	01228029	01228029	01236577	01236579	01239459	01239459	01241187	01241187
00000045	00000045	00081962	00081963	01228030	01228030	01236580	01236580	01239460	01239460	01241589	01241589
00000244	00000381	00082925	00082937	01228031	01228031	01236581	01236587	01239461	01239461	01241597	01241598
00000382	00000509	00085677	00085677	01228032	01228032	01236588	01236593	01239462	01239462	01243410	01243629
00000510	00000632	00085679	00085679	01228033	01228033	01236594	01236595	01239463	01239463	01243875	01243995
00002198	00002202	00085680	00085680	01228034	01228034	01236596	01236604	01239464	01239464	01245599	01245617
00002226	00002230	00085682	00085682	01228035	01228035	01236605	01236609	01239465	01239465	01245618	01245618
00024810	00024810	00085687	00085687	01228036	01228036	01236610	01236612	01239466	01239466	01245619	01245640
00024815	00024815	00086088	00086088	01228037	01228037	01236613	01236615	01239467	01239469	01245641	01245672
00024817	00024817	00087449	00087449	01228038	01228038	01236616	01236617	01239470	01239470	01245673	01245703
00024819	00024819	00087451	00087451	01228039	01228039	01236618	01236644	01239471	01239471	01245704	01245705
00024820	00024820	00087699	00087702	01228040	01228040	01236645	01236653	01239472	01239472	01245706	01245719
00024825	00024825	00087854	00087856	01228041	01228041	01236654	01236666	01239473	01239473	01245720	01245726
00024826	00024826	00088045	00088303	01228042	01228042	01236667	01236670	01239474	01239474	01245727	01245755
00024837	00024837	00088371	00088386	01228043	01228043	01236671	01236677	01239475	01239475	01245756	01245793
00024838	00024838	00088390	00088408	01228044	01228044	01236678	01236682	01239476	01239476	01245794	01245813
00024841	00024841	00088655	00088655	01228045	01228045	01236683	01236683	01239477	01239477	01245814	01245837
00024844	00024844	00088892	00088903	01228046	01228046	01236684	01236690	01239478	01239478	01245838	01245848
00024851	00024851	00088906	00088918	01228047	01228047	01236691	01236697	01239479	01239479	01245849	01245890
00032604	00032604	00092674	00092679	01228048	01228048	01236698	01236699	01239483	01239483	01245891	01245914
00032650	00032654	00092784	00092787	01228049	01228049	01236700	01236702	01239485	01239485	01245915	01245938
00037713	00037713	00094543	00094545	01228050	01228050	01236703	01236707	01239486	01239486	01245939	01245940
00037718	00037718	00095578	00095578	01228051	01228051	01236708	01236710	01239488	01239488	01245941	01245978
00037729	00037729	00095579	00095579	01228052	01228052	01236711	01236730	01239490	01239490	01245979	01246020
00040078	00040080	00095580	00095580	01228053	01228053	01236731	01236733	01239493	01239493	01246021	01246042
00040237	00040241	00097527	00097528	01228054	01228054	01236734	01236739	01239495	01239495	01246043	01246066
00040283	00040285	00098968	00099018	01228055	01228055	01236740	01236742	01239504	01239504	01246067	01246085
00040289	00040306	00109518	00109560	01228056	01228056	01236743	01236744	01240202	01240203	01246086	01246111
00044650	00044692	00109734	00109750	01228057	01228057	01238999	01239003	01240204	01240225	01246112	01246134
00045250	00045253	00109778	00109778	01228058	01228058	01239440	01239440	01240226	01240236	01246135	01246157
00045262	00045264	00109791	00109803	01228059	01228059	01239441	01239441	01240237	01240280	01246158	01246194
00045266	00045276	00109806	00109819	01228060	01228060	01239442	01239442	01240281	01240282	01246195	01246197
00045334	00045335	00109822	00109852	01228061	01228061	01239443	01239443	01240283	01240304	01246198	01246224
00045393	00045393	00109855	00109865	01228062	01228062	01239444	01239444	01240305	01240307	01246225	01246227
00051071	00051073	00109982	00109985	01228063	01228063	01239445	01239445	01240308	01240325	01250306	01250306
00051088	00051088	00109991	00109991	01228064	01228064	01239446	01239446	01240326	01240353	01250307	01250307
00052794	00052816	01215343	01215344	01228065	01228065	01239447	01239447	01240354	01240381	01259704	01259704
00056424	00056433	01215409	01215409	01228066	01228066	01239448	01239448	01240382	01240391	01259705	01260105
00056439	00056441	01215423	01215423	01228073	01228073	01239449	01239449	01240392	01240412	01260121	01260391
00056519	00056529	01215632	01215633	01228074	01228074	01239450	01239450	01240413	01240437	01260418	01260686
00056538	00056552	01215634	01215653	01228075	01228075	01239451	01239451	01240438	01240447	01262030	01262366
00056882	00056894	01215997	01216001	01233718	01233718	01239452	01239452	01240448	01240448	01266931	01266990
00056900	00056909	01228026	01228026	01235144	01235144	01239453	01239453	01240449	01240469	01266995	01267070

Arm Ltd. v. Qualcomm, Inc., Qualcomm Technologies, Inc. and Nuvia, Inc.
Documents and Other Information Considered

Schedule 2

ARM_	
Begin	End
01271909	01271926
01271927	01271928
01271929	01271953
01305479	01305479
01305515	01305515
01309668	01309669
01427450	01427492
01427493	01427522
01427523	01427537

MASA_	
Begin	End
00001719	00001724

QCARM_	
Begin	End
0002821	0002823
0002825	0002827
0363482	0363482
0550518	0550529
0557206	0557207
0569461	0569494
0584330	0584332
0591730	0591732
0591733	0591736
0591737	0591740
0591741	0591745
0592425	0592431
2414807	2414813
2417783	2417783
2423231	2423233
2424464	2424466
2424496	2424498
2424621	2424623
2425046	2425048
2425297	2425299
2426801	2426803
2426804	2426806
2426807	2426814
2426815	2426821
2426822	2426836
2426837	2426852
2426853	2426855

QCARM_	
Begin	End
2426856	2426881
2426882	2426882
2426883	2426884
2426885	2426887
2426888	2426888
2426889	2426891
2426892	2426894
2426895	2426897
2554114	2554116
3241389	3241393
3337797	3337799
3400486	3400548
3404294	3404353
3426632	3426638
3437962	3438003
3438004	3438037
3438038	3438074
3438075	3438113
3438114	3438152
3438153	3438193
3438194	3438234
3438235	3438275
3452409	3452442
3452662	3452664
3452665	3452667
3452668	3452672
3452720	3452723
3452805	3452807
3453808	3453810
3453866	3453868
3453870	3453872
3453873	3453874
3453875	3453877
3453879	3453881
3454302	3454304
3457104	3457104
3460229	3460233
3460451	3460453
3519910	3519912
3520810	3520812
3520813	3520815
3520816	3520818
3520819	3520821

QCARM_	
Begin	End
3520822	3520825
3520826	3520829
3520830	3520834
3522610	3522611
3526546	3526553
3536886	3536888
3536889	3536891
3536892	3536894
3536895	3536897
3536898	3536901
3536902	3536905
3536921	3536933
3537376	3537378
3537773	3537776

Arm Ltd. v. Qualcomm, Inc., Qualcomm Technologies, Inc. and Nuvia, Inc.
Documents and Other Information Considered

Legal Documents and Related Exhibits

2022-08-31 - Complaint
2022-10-26 - Defendants' Answer and Defenses to Plaintiff's Complaint and Jury Demand and Defendants' Amended Counterclaim
2023-02-27 - Arm Ltd.'s Objections and Responses to Qualcomm's First Set of Interrogatories, Nos. 1-11
2023-02-27 - Arm Ltd.'s Objections and Responses to Qualcomm's First Set of Requests for Production, Nos. 1-36
2023-02-27 - Defendants' Responses and Objections to Plaintiff's First Set of Interrogatories, Nos. 1-13
2023-02-27 - Defendants' Responses and Objections to Plaintiff's First Set of Requests for Production, Nos. 1-51
2023-04-04 - Arm Ltd.'s First Amended Objections and Responses to Qualcomm's First Set of Requests for Production, Nos. 1-36
2023-04-26 - Corrected Second Amended Complaint for Willful Patent Infringement
2023-05-04 - Defendants' Responses and Objections to Plaintiff's Second Set of Requests for Production, Nos. 52-58
2023-05-05 - Arm Ltd.'s First Objection and Responses to Qualcomm's Second Set of Requests for Production, Nos 37-50
2023-06-23 - Defendants' First Supplemental Responses and Objections to Plaintiff's First Set of Interrogatories, Nos. 1-4 and 6
2023-07-14 - Arm Ltd.'s First Objection and Responses to Qualcomm's Third Set of Requests for Production, Nos. 51-54
2023-08-23 - Defendants' Responses and Objections to Plaintiff's Third Set of Requests for Production, Nos. 59-122
2023-10-02 - Arm Ltd.'s Objections and Responses to Qualcomm's Second Set of Interrogatories, Nos. 12-19
2023-10-02 - Plaintiff Arm Ltd.'s Objections and Responses to Defendant Qualcomm's Fourth Set of Requests for Production, Nos. 55-70
2023-10-20 - Defendants' Responses and Objections to Plaintiff's First Set of Requests for Admission, Nos. 1-30
2023-10-26 - Defendants' Supplemental and Amended Response and Objections to Plaintiff's First Set of Interrogatories, No. 5
2023-10-26 - Correspondence Email from J. Braly to J. Li
2023-10-27 - Defendants' Responses and Objections to Plaintiff's Second Set of Interrogatories
2023-11-09 - Arm Ltd.'s Objections and Responses to Qualcomm's Third Set of Interrogatories, No. 20
2023-11-17 - Arm Ltd.'s First Supplemental Objections and Responses to Qualcomm's Second Set of Interrogatories, Nos. 12-19
2023-11-17 - Arm Ltd.'s Objections and Responses to Qualcomm's Fourth Set of Interrogatories, Nos. 21-25
2023-11-17 - Arm Ltd.'s Second Supplemental Objections and Responses to Qualcomm's First Set of Interrogatories, Nos. 1-11
2023-11-17 - Arm Ltd.'s Supplemental Objections and Responses to Qualcomm's Third Set of Interrogatories, No. 20
2023-11-17 - Defendants' First Supplemental Reponses and Objections to Plaintiff's Second Set of Interrogatories, Nos. 15-16
2023-11-17 - Defendants' Responses and Objections to Plaintiff's Fourth Set of Requests for Production, No. 123
2023-11-17 - Plaintiff Arm Ltd.'s Objection and Responses to Defendant Qualcomm's Fifth Set of Requests for Production, Nos. 71-124
2023-11-17 - Plaintiff Arm Ltd.'s Responses and Objections to Qualcomm's First Requests for Admissions to Plaintiff, Nos. 1-30

Deposition Transcripts and Related Exhibits

2023-09-22 - Rohit Singh	2023-11-02 - Lynn Couillard	2023-11-28 - Jim Thompson	2023-12-08 - Jonathan Armstrong
2023-10-12 - Manu Gulati	2023-11-03 - Gerard Williams	2023-11-28 - Michael Roberts	2023-12-12 - Rene Haas
2023-10-20 - Ramakrishna Chundur	2023-11-08 - Ziad Asghar	2023-11-29 - Lynn Bos	2023-12-14 - Vivek Agrawal
2023-10-25 - Jignesh Trivedi	2023-11-09 - Paul Williamson	2023-11-30 - Karthik Shivashankar	2023-12-14 - Laura Sand
2023-10-25 - Tim Herbert	2023-11-15 - Christiano Amon	2023-12-01 - Pradeep Kanapathipillai	2023-12-19 - Christine Tran (rough transcript)
2023-10-27 - Nitin Sharma	2023-11-15 - Richard Grisenthwaite	2023-12-07 - Mark Werkheiser	2023-12-20 - Ian Thornton (rough transcript)
2023-10-27 - Will Abbey	2023-11-16 - Simon Segars	2023-12-08 - Geeta Balakrishnan	

Publicly Available Information/Other

Bhandarkar, Dileep, and Douglas W. Clark. "Performance from architecture: comparing a RISC and a CISC with similar hardware organization." Proceedings of the fourth international conference on Architectural support for programming languages and operating systems. 1991
NuVia, Inc., Private Company Profile, S&P Capital IQ
Qualcomm Inc. Form 10-K for the fiscal year ended September 24, 2023
Qualcomm Inc. Form 10-K for the fiscal year ended September 26, 2021
https://community.fs.com/article/what-is-a-server-cpu.html

Arm Ltd. v. Qualcomm, Inc., Qualcomm Technologies, Inc. and Nuvia, Inc.
Documents and Other Information Considered

Schedule 2

Publicly Available Information/Other (cont.)
https://hbr.org/2022/08/in-uncertain-times-the-best-strategy-is-adaptability
https://investor.qualcomm.com/segments/qct
https://medium.com/silicon-reimagined/performance-delivered-a-new-way-8f0f5ed283d5
https://podcasts.apple.com/us/podcast/qualcomm-ceo-on-what-he-really-thinks-of-apple/id1091374076?i=1000565773375)
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https://web.archive.org/web/20210115193713/https://nuviainc.com/
https://web.archive.org/web/20210316180114/https://nuviainc.com/
https://web.archive.org/web/20210422062904/https://nuviainc.com/nuvia-raises-53-million-to-reimagine-silicon-design-for-the-data-center/
https://www.arm.com/architecture/cpu
https://www.arm.com/glossary/cpu
https://www.arm.com/glossary/isa
https://www.arm.com/glossary/risc
https://www.arm.com/glossary/soc-development
https://www.arm.com/partners
https://www.cnbc.com/2022/09/01/why-arms-lawsuit-against-qualcomm-is-a-big-deal.html
https://www.cnbc.com/2023/09/14/arm-ipo-what-is-risc-v-and-why-does-arm-call-the-rival-product-a-risk.html
https://www.currency.me.uk/convert/gbp/usd
https://www.digitaltrends.com/computing/what-is-a-cpu/
https://www.forbes.com/sites/jonmarkman/2023/12/05/qualcomms-x-elite-crushes-apple-arm-holdings-stocks-surge/?sh=5f330d9e7d04
https://www.forbes.com/sites/startswithabang/2018/02/13/chaos-theory-the-butterfly-effect-and-the-computer-glitch-that-started-it-all/?sh=4b460bee69f6
https://www.gigabyte.com/Article/server-processors-the-core-of-a-server-s-performance
https://www.gigabyte.com/Glossary/cisc
https://www.intel.com/content/www/us/en/newsroom/resources/moores-law.html
https://www.investopedia.com/articles/markets/012216/worlds-top-10-semiconductor-companies-tsmintc.asp
https://www.lenovo.com/us/en/glossary/cpu-core/
https://www.pcmag.com/news/qualcomm-snapdragon-x-elite-[redacted]s
https://www.pcworld.com/article/1382740/qualcomm-dubs-nuvia-cpu[redacted]
https://www.precedenceresearch.com/microprocessor-market
https://www.qualcomm.com/news/releases/2021/01/qualcomm-acquire-nuvia
https://www.qualcomm.com/news/releases/2021/03/qualcomm-completes-acquisition-nuvia
https://www.qualcomm.com/products
https://www.qualcomm.com/snapdragon/overview
https://www.techspot.com/article/1856-aiming-for-atoms-chip-manufacturing/

This list incorporates reference to all documents identified in the footnotes of my report.

Exhibit 4

UNITED STATES DISTRICT COURT
DISTRICT OF DELAWARE

ARM LTD., a U.K. corporation, Plaintiff, v. QUALCOMM INC., a Delaware corporation, QUALCOMM TECHNOLOGIES INC., a Delaware corporation, and NUVIA, INC., a Delaware corporation, Defendants.	Civil Action No. 1:22-cv-01146

EXPERT REPORT OF PROFESSOR GUHAN SUBRAMANIAN

DECEMBER 20, 2023

CONTENTS

 CONFIDENTIAL

I. BACKGROUND

A. Qualifications

1. I serve as the H. Douglas Weaver Professor of Business Law at the Harvard Business School ("HBS") and the Joseph Flom Professor of Law and Business at the Harvard Law School ("HLS"). I am the first person in the history of Harvard University to hold tenured appointments at both HBS and HLS. I have taught at HBS and/or HLS continuously since 1999. At Harvard I serve as the faculty chair for the JD/MBA program and the Advisory Committee on Shareholder Responsibility. I hold degrees in Economics, Law, and Business from Harvard University.

2. My research and publications focus on issues of corporate negotiations, corporate law, and corporate governance. I am a co-author (with former Delaware Chancellor William T. Allen and HLS professor Reiner Kraakman) of *Commentaries and Cases on the Law of Business Organization* (4th ed. 2012), a leading textbook on corporate law. I am also the author of *Dealmaking: The New Strategy of Negotiauctions* (2nd ed. 2020) ("Dealmaking"), a practitioner-oriented book that provides guidance for managing complex business transactions.

3. I am the co-author of *Deals: The Economic Structure of Business Transactions* (forthcoming Harvard University Press 2024). This book provides an economic

analysis of deal terms in corporate transactions. It examines challenges such as moral hazard, information asymmetries, and asset specificity, and then describes how deal terms can be used to overcome these barriers to contracting. Economics Nobel Prize Winner Oliver Hart states: "Klausner and Subramanian's book will be an invaluable resource for anyone who wants to understand real-world contracts and deals. The authors present many interesting cases and skillfully use basic economic ideas to understand them. There are many insights for practitioners, but academics will also learn a great deal and will be stimulated to refine their theories."

4. Twelve of my academic articles have been selected by scholars in the field as being among the "top ten" articles published in corporate and securities law in their respective years, among the 400+ articles that are published each year. The two-volume treatise *Law and Economics of Mergers and Acquisitions*, which includes thirty-three "seminal" articles published over the past fifty years, contains four of my articles, more than from any other scholar.[1] My article Corporate Governance 2.0, was selected as a McKinsey Award finalist for best article published in the *Harvard Business Review* in 2015.

[1] *Law and Economics of Mergers and Acquisitions*. Eds. Steven Davidoff Solomon and Claire A. Hill. United Kingdom: Edward Elgar Publishing (2013).

5. In 2013, I delivered the annual Pileggi Lecture to the Delaware judiciary, members of the Delaware bar, and law students in Wilmington, Delaware. According to the *Delaware Journal of Corporate Law*, the lecturer is always "a leading voice in corporate law."[2] In his introduction of my lecture, former Delaware Supreme Court Chief Justice Leo Strine stated: "[T]oday we have a speaker who epitomizes excellence in corporate law."[3]

6. I have been similarly recognized by the members of the Delaware Chancery Court. In October 2018, for example, Vice Chancellor Sam Glasscock noted that "Professor Guhan Subramanian is a recognized expert in corporate affairs … and has been recognized by this Court as helpful on many occasions."[4] Delaware Chancellor Kathaleen McCormick recently observed that my "published work concerning policy questions of corporate law fill the footnotes of many decisions of Delaware courts."[5]

7. At HLS, I teach the basic course on Corporate Law. I also teach a joint course between HLS and HBS entitled *Deals*, which focuses on complex business

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2 Lectures & Symposia. *Delaware Journal of Corporate Law*. <https://djcl.org/symposium-lectures> (accessed Feb. 27, 2023); "Past Pileggi Lecture Keynote Speakers." *Delaware Journal of Corporate Law*. <https://djcl.org/home-2-2-2-2> (accessed Feb. 27, 2023).

3 Video on file with author.

4 *In re Starz Appraisal*, No. 12968-VCG, 2018 WL 4922095, at *1 (Del. Ch. Oct. 10, 2018).

5 *In re Williams Cos. Stockholder Litigation*, No. 2020-0707-KSJM, 2021 WL 754593, at 24 n. 141 (Feb. 26, 2021). At the time of the opinion, Kathaleen McCormick was Vice Chancellor.

transactions.[6] At HBS, I teach in several executive education programs, such as *Strategic Negotiations*, *Changing the Game*, *Making Corporate Boards More Effective*, and *Preparing to be a Corporate Director*. I am the faculty chair for the week-long HBS executive education course *Mergers & Acquisitions*, and within that course I teach the module on "Deal Execution." I also present on developments in corporate governance and transactional practice to the American College of Corporate Directors, a national association of public-company directors.

8. Since 2018, I have served as the faculty chair for the HLS Program on Negotiation ("PON").[7] Founded in 1983, PON includes faculty, graduate students, and staff from Harvard University, the Massachusetts Institute of Technology and Tufts University, among other schools. The mission of PON is to "develop[] the theory and practice of negotiation, to nurtur[e] the next generation of negotiation teachers and scholars, and to help[] students become

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6 More information on this course can be found at Harvard Law Today. *See* Deakin, Michelle. "Designing the Deal." *Harvard Law Bulletin* (Sept. 1, 2005). <https://hls.harvard.edu/today/designing-the-deal> (accessed Feb. 27, 2023); McArdle, Elaine. "Bridging Theory and Practice in Corporate Law." *Harvard Law Bulletin* (Jan. 24, 2012). <https://hls.harvard.edu/today/bridging-theory-and-practice-in-corporate-law> (accessed Feb. 27, 2023).

7 *See* Perkins, Christine. "Subramanian Will Succeed Mnookin as Program on Negotiation Chair." *Harvard Law Today* (Mar. 15, 2018). <https://hls.harvard.edu/today/subramanian-will-succeed-mnookin-program-negotiation-chair> (accessed Mar. 6, 2023).

more effective negotiators."[8] Over the past thirty-five years, PON faculty, including myself, have taught tens of thousands of businesspeople around the world how to become more effective negotiators. In particular, I have taught in the *Negotiation & Leadership* program and the PON *Master Class*. PON Global, a program that I spearheaded in 2016, has been taught to more than a thousand executives in ten countries around the world.[9]

9. Since 2013, I have served as a director of LKQ Corporation (NASDAQ: LKQ), a Fortune 500 company in the automotive sector ("LKQ"). LKQ is incorporated in Delaware and has operations throughout the U.S., Canada, and Europe. In 2022, LKQ had approximately $13 billion in annual revenues, 50,000 employees, and $15 billion in market capitalization; it is currently #319 on the Fortune 500 list.[10] I am formerly the Chair of the Nominating/Governance Committee and the Lead Independent Director. I currently serve as Chairman of the Board.

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8 "Welcome to the Program on Negotiation (PON)." *Harvard Program on Negotiation*. <https://www.pon.harvard.edu/about> (accessed Mar. 6, 2023).

9 *See* "PON Global." *Harvard Program on Negotiation* (May 20, 2022). <https://web.archive.org/web/20220520141129/https://www.pon.harvard.edu/category/pon-global> (accessed Mar. 13, 2023).

10 "Fortune 500." *Fortune* (2023). <https://fortune.com/ranking/fortune500/2023/search/?Name=lkq> (accessed June 8, 2023).

10. During my ten years on the LKQ board, the company has made more than a hundred acquisitions. I have been involved in the negotiation and execution of several of the most significant acquisitions, including Sator Beheer for approximately $268 million (May 2013),[11] Rhiag-Inter Auto Parts Italia S.p.A. for €1.0 billion (March 2016),[12] Stahlgruber GmbH for €1.5 billion (May 2018),[13] and Uni-Select. Inc. for $2.1 billion (February 2023).[14]

11. I am regularly retained as an advisor or expert witness in complex corporate transactions. I also advise individuals, boards of directors, and management

[11] Knight, Meribah. "LKQ Acquires Netherlands Auto Parts Distributor for $268 Million." *Crain's Chicago Business* (Apr. 25, 2013). <https://www.chicagobusiness.com/article/20130425/NEWS05/130429834/lkq-acquires-netherlands-auto-parts-distributor> (accessed Feb. 27, 2023); "LKQ Corporation Finalizes Acquisition of Sator Beheer." *GlobeNewswire* (May 1, 2013). <https://www.globenewswire.com/news-release/2013/05/01/543410/10030936/en/%20LKQ-Corporation-Finalizes-Acquisition-of-Sator-Beheer.html> (accessed Feb. 27, 2023).

[12] "LKQ Corporation Announces Agreement to Acquire Rhiag-Inter Auto Parts Italia S.p.A." *GlobeNewswire* (Dec. 22, 2015). <https://www.globenewswire.com/news-release/2015/12/22/797609/0/en/LKQ-Corporation-Announces-Agreement-to-Acquire-Rhiag-Inter-Auto-Parts-Italia-S-p-A.html> (accessed Feb. 27. 2023); "LKQ Corporation Finalizes Acquisition of Rhiag-Inter Auto Parts Italia S.p.A." *GlobeNewswire* (Mar. 21, 2016). <https://www.globenewswire.com/news-release/2016/03/21/821696/0/en/LKQ-Corporation-Finalizes-Acquisition-of-Rhiag-Inter-Auto-Parts-Italia-S-p-A.html> (accessed Feb. 27, 2023).

[13] "LKQ Corporation Announces Agreement to Acquire Stahlgruber GmbH." *GlobeNewswire* (Dec. 11, 2017). <https://www.globenewswire.com/news-release/2017/12/11/1250656/0/en/LKQ-Corporation-Announces-Agreement-to-Acquire-Stahlgruber-GmbH.html> (accessed Feb. 27, 2023); "LKQ Corporation Finalizes Acquisition of Stahlgruber GmbH." *GlobeNewswire* (May 31, 2018). <https://www.globenewswire.com/news-release/2018/05/31/1514504/0/en/LKQ-Corporation-Finalizes-Acquisition-of-STAHLGRUBER-GmbH.html> (accessed Feb. 27, 2023).

[14] "LKQ Corporation Enters into Definitive Agreement to Acquire Uni-Select Inc." *Uni-Select* (Feb. 27, 2023). <https://uniselect.com/content/files/LKQ-Corp-Acquisition-of-Uni-Select-Press-Release-Final.pdf> (accessed Feb. 27, 2023).

teams on issues of deal-making and corporate governance, and I have participated in several significant transactions as a member of the LKQ board of directors. Over the past fifteen years, I have been involved as an advisor, expert witness, or corporate director in deals or situations worth over $150 billion in aggregate value.

12. I have testified as an expert witness approximately twenty times at trial or arbitration hearing, and numerous times by deposition, for both plaintiffs and defendants, in disputes concerning corporate transactions, deal process design, corporate governance, and M&A, and have never been disqualified as an expert in these fields. My Curriculum Vitae, which includes a complete listing of my academic publications and expert witness testimony over the past five years, is attached as **Appendix A**: *Curriculum Vitae*.

B. Statement of Assignment

13. On August 31, 2022, Arm Ltd. ("Arm"), a provider of microprocessor intellectual property ("IP") for use in semiconductor chips and other electronic devices, filed a complaint against Qualcomm Inc., Qualcomm Technologies, Inc. (collectively, "Qualcomm"), and NuVia, Inc. ("Nuvia") asking for specific

performance of termination provisions contained in licenses entered into by Nuvia and Arm.[15]

14. The complaint rests upon licenses that Arm negotiated with Nuvia in 2019 permitting Nuvia to license Arm's architecture to build custom processor cores.[16] Qualcomm acquired Nuvia in 2021.[17]

15. I have been retained by Arm, through its counsel Morrison & Foerster LLP, to answer the following questions:

1) What principles of negotiation theory and transactional practice are relevant in assessing the initial negotiation of the licensing agreements negotiated between Arm and Nuvia?

2) What principles of negotiation theory and transactional practice are relevant in assessing Qualcomm's acquisition of Nuvia?

3) What principles of negotiation theory and transactional practice are relevant for assessing the [redacted] in the Arm-Nuvia ALA?

4) Is it possible to predict the outcome of a hypothetical successful negotiation between Qualcomm and Arm over a transfer of Nuvia's ALAs to Qualcomm?

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15 Complaint. *Arm Ltd. v. Qualcomm Inc., Qualcomm Technologies, Inc., and NuVia, Inc.* (D. Del. No. 1:22-cv-01146) (Aug. 31, 2022) ("Complaint") ¶¶ 1-3.

16 *Id.* ¶¶ 20-22.

17 "Qualcomm to Acquire NUVIA." *Qualcomm* (Jan. 12, 2021). <https://www.qualcomm.com/news/releases/2021/01/qualcomm-acquire-nuvia> (accessed Sept. 12, 2023).

16. A complete list of the documents and data that I rely upon in reaching my conclusions in this matter is provided in **Appendix B**: *Materials Considered*.

17. The current hourly rate for my work is $1,950. My compensation is not affected by my findings or the outcome of this litigation. I supervised and directed a team at Vega Economics to assist me in this assignment, and I receive further compensation based on their billings. Their compensation is not affected by my findings or the outcome of this litigation.

18. I hold the opinions stated in this report with a reasonable degree of professional certainty. I reserve the right to amend or supplement my opinions and report, if appropriate, based on any additional discovery, or in response to opinions or reports of other experts in this matter.

C. Summary of Opinions

19. Based on my review of the record, my experience, and my professional judgment, I conclude that:

1) Arm entered into a limited number of ALA contracts, and each was negotiated separately. Consistent with negotiation principles, Arm negotiated different provisions with Nuvia and Qualcomm.

2) Due diligence in an M&A transaction typically involves an examination of license agreements. Consistent with norms in transactional practice, Qualcomm and Nuvia seemed to be aware of the [redacted] in the ALAs.

3) Consistent with the business objectives of CIC provisions and negotiation principles, [redacted]

4) As a matter of negotiation theory, it is not feasible to predict with great precision the outcome of a hypothetical successful negotiation between Qualcomm and Arm over a transfer of Nuvia's ALAs to Qualcomm. This means that contractual terms that were considered during the parties' previous negotiations cannot simply be adopted later in order to make the parties whole. This is especially true now that Qualcomm's conduct and the resulting publicity of this lawsuit means that there must be a consideration of harm to Arm, not just the benefit to Qualcomm from the Nuvia ALA transfer.

20. My full conclusions are contained in the body of this report.

II. Summary of Relevant Facts

21. I assume the following facts to be true for purposes of my analysis. To my knowledge, these facts are uncontested between the parties.

22. Arm is a developer of IP related to microprocessor architectures and designs.[18] A microprocessor architecture "defines behavior that is common to many processor designs," while the processor itself "is an implementation of an architecture, and can be integrated into several different designs."[19] Arm

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[18] "The ARM Processor Business Model." *Arm*. <https://developer.arm.com/documentation/dht0001/a/architectures--processors--and-devices/the-arm-processor-business-model> (accessed Sept. 12, 2023).

[19] *Id.*

processor designs and architectures are integrated into silicon semiconductor chips, system-on-chip devices, or other specialized computing platforms.[20] Instead of manufacturing chips itself, Arm licenses its processor technology to companies making chips or other electronic devices.[21]

23. Arm was founded in 1990 and has spent decades developing its leading processor technology.[22] Approximately 80 percent of Arm's employees are focused on research and design of Arm's technology.[23] Arm's processor designs and architectures are used by leading companies across the globe, including AMD, Intel, MediaTek, Nvidia, Samsung, and others.[24]

24. Arm makes money from licensing its IP to partner companies, both by collecting an upfront license fee and a royalty based on the selling price of the chip.[25] In pursuit of this goal of monetizing its IP, Arm provides support to

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20 *Id.*; "Licensing Arm Technology: Access for Everyone." *Arm*. <https://www.arm.com/products/licensing> (accessed Sept. 12, 2023).

21 "The ARM Processor Business Model." *Arm*. <https://developer.arm.com/documentation/dht0001/a/architectures--processors--and-devices/the-arm-processor-business-model> (accessed Sept. 12, 2023).

22 Arm Holdings plc. *Amendment No. 2 to Form F-1 Registration Statement* (Sept. 5, 2023). <https://www.sec.gov/Archives/edgar/data/1973239/000119312523228059/d393891df1a.htm> (accessed Dec. 14, 2023) ("Arm Registration Statement") at 3.

23 *Id.* at 2.

24 *Id.* at 1.

25 Abbey, Will. Deposition (Oct. 27, 2023) ("Abbey Dep.") 72:13-73:12, 100:2-102:19; Shimpi, Anand Lal. "The ARM Diaries, Part 1: How ARM's Business Model Works." *AnandTech* (June 28, 2013). <https://www.anandtech.com/show/7112/the-arm-diaries-part-1-how-arms-business-model-works> (accessed Sept. 12, 2023).

companies developing technology based on Arm-designed components or architectures.[26] Arm also negotiates license agreements with each customer that seeks to implement its technology.[27]

25. Arm may enter into different types of license agreements with its customers based on how the licensee intends to use Arm technology.[28] One common contractual licensing agreement Arm uses is the Technology License Agreement ("TLA"), which allows for licensees to use specified "off-the-shelf" Arm processor core designs.[29] Architecture License Agreements ("ALAs"), on the other hand, are far more open-ended and flexible, as they allow the customer

26 Abbey Dep. 33:15-34:24; "Licensing Arm Technology: Access for Everyone." *Arm*. <https://www.arm.com/products/licensing> (accessed Sept. 12, 2023) (describing the "manufacture rights, tools, support and training" included with total access subscription to Arm's IP); Shimpi, Anand Lal. "The ARM Diaries, Part 1: How ARM's Business Model Works." *AnandTech* (June 28, 2013). <https://www.anandtech.com/show/7112/the-arm-diaries-part-1-how-arms-business-model-works/2> (accessed Sept. 12, 2023) (stating that, for architectural licenses, "ARM will offer some support to help you with your design").

27 Shimpi, Anand Lal. "The ARM Diaries, Part 1: How ARM's Business Model Works." *AnandTech* (June 28, 2013). <https://www.anandtech.com/show/7112/the-arm-diaries-part-1-how-arms-business-model-works> (accessed Sept. 12, 2023) ("Both the up front license fee and the royalty are negotiable. There are discounts for multiple ARM cores used in a single design. This is where things like support contracts come into play."). *See also* Abbey Dep. 69:8-19.

28 Arm Registration Statement at 87; Abbey Dep. 75:12-77:18; Grisenthwaite, Richard. Deposition (Nov. 15, 2023) 24:1-25:4; Shimpi, Anand Lal. "The ARM Diaries, Part 1: How ARM's Business Model Works." *AnandTech* (June 28, 2013). <https://www.anandtech.com/show/7112/the-arm-diaries-part-1-how-arms-business-model-works> (accessed Sept. 12, 2023) ("Both the up front license fee and the royalty are negotiable. There are discounts for multiple ARM cores used in a single design. This is where things like support contracts come into play.").

29 Segars, Simon. Deposition (Nov. 16, 2023) ("Segars Dep.") 29:23-30:21; Abbey Dep 75:12-24.

to design custom processor cores based on Arm's architectures.[30] The vast majority of Arm's agreements are TLAs, with Arm granting very few ALAs to date.[31] Companies that have negotiated ALAs with Arm generally require significant support from Arm for their research and development ("R&D") process for the custom processor cores.[32]

26. Because Arm's business model relies on monetizing its research and the resulting IP, the specific licenses governing allowed usage and agreed compensation for Arm's technology are extremely important to the company.[33]

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30 Segars Dep. 30:12-32:12; Abbey Dep. 76:11-77:20.

31 Arm Registration Statement at 88 ("Historically, most customers licensed our products under the terms of a TLA."), 133 ("A very small number of companies want to design customized Arm CPUs for their next-generation chips. For these companies, we can provide an architecture license which allows the licensee to develop their own CPU design that is compliant with the Arm ISA."); Shimpi, Anand Lal. "The ARM Diaries, Part 1: How ARM's Business Model Works." *AnandTech* (June 28, 2013). <https://www.anandtech.com/show/7112/the-arm-diaries-part-1-how-arms-business-model-works> (accessed Sept. 12, 2023) ("In terms of numbers, ARM has around 1000 licenses in the market spread across 320 licensees/partners. Of those 320 licensees, only 15 of them have architecture licenses."). *See also* Segars Dep. 31:2-4.

32 Segars Dep. 31:15-24, 42:24-44:19; Williamson, Paul. Deposition (Nov. 9, 2023) ("Williamson Dep.") 21:10-23:18.

33 [redacted] Arm Registration Statement at 87 ("We generate the majority of our revenue from customers who enter into license agreements, pursuant to which we receive royalty fees based on average selling price of the customer's Arm-based chip or a fixed fee per chip. Royalty revenues are impacted primarily by the adoption of our products by the licensee as well as other factors, such as product lifecycles, customer's business performance, market trends and global supply constraints. In the fiscal year ended March 31, 2023, royalty revenue represented 63% of our total revenue.").

Arm's licenses, and its ALAs in particular, carefully and specifically designate the technology that can be used by the customer to develop its processor cores.[34]

27. Nuvia, a chip maker founded by ex-Apple and Google engineers, obtained both an Arm ALA and an Arm TLA in 2019 and began developing the Phoenix core, a custom central processing unit ("CPU") core based on the Arm architecture.[35] These license agreements that Arm negotiated with Nuvia established licensing fees and royalty rates that reflected the scope and nature of Nuvia's intended usage of Arm's IP.[36] [redacted]

28. The negotiations between Nuvia and Arm over Nuvia's licensing agreements proceeded as follows:

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34 Complaint ¶ 19; Arm Registration Statement at 87 ("Under an ALA, the licensee is allowed to develop their own highly customized CPU designs that is compliant with the Arm ISA for a fixed architecture license fee. As the creation of an optimized CPU is very costly and time consuming, architecture licensees will often also license Arm CPU designs to use either as a complementary processor alongside the licensee's Arm-compliant CPU design, or in other chips where the licensee's own design is unsuitable.").

35 Tyson, Mark. "Nuvia 'Clean-Sheet CPU Design' Performance Previewed." *Hexus* (Aug. 11, 2020). <https://hexus.net/tech/news/cpu/144733-nuvia-clean-sheet-cpu-design-performance-previewed> (accessed Sept. 12, 2023); Gulati, Manu. 30(b)(1) Deposition (Oct. 12, 2023) ("Gulati Dep.") 40:19-46:18.

36 [redacted]

37 Technology License Agreement ("ALA") Between Arm Limited and NuVia, Inc. (Sept. 27, 2019) (ARM_00059183 at ARM_00059197) ("Nuvia ALA"). *See also* Segars Dep. 82:12-21, 105:1-106:21.

- [redacted].[38]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]
- [redacted]

38 [redacted]

39 [redacted]

40 [redacted]

[redacted]

CONFIDENTIAL

[redacted]

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- [redacted]

44 [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

- [redacted]

29. In January of 2021, Qualcomm acquired Nuvia and indicated that it planned to integrate Nuvia's CPU designs into Qualcomm products.[52] However, neither Nuvia nor Qualcomm provided notice of the acquisition to Arm, and neither obtained Arm's consent to transfer or assign Nuvia's licenses to Qualcomm, in alleged breach [redacted][53]

III. Negotiation Theory and Application to Licensing Agreements

A. Core Negotiation Terminology: BATNA, ZOPA, and Reservation Value

30. The best alternative to a negotiated agreement ("BATNA") for both sides determines the bargaining range for any negotiation.[54] In a price negotiation,

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[redacted]

51 [redacted]

52 "Qualcomm to Acquire NUVIA." *Qualcomm* (Jan. 12, 2021). <https://www.qualcomm.com/news/releases/2021/01/qualcomm-acquire-nuvia> (accessed Sept. 12, 2023) (announcing the acquisition plan and stating that "NUVIA CPUs are expected to be integrated across Qualcomm Technologies' broad portfolio of products, powering flagship smartphones, next-generation laptops, and digital cockpits, as well as Advanced Driver Assistance Systems, extended reality and infrastructure networking solutions."). *See also* Williams, [redacted]

53 Complaint ¶ 28.

54 Subramanian, Guhan. *Dealmaking: The New Strategy of Negotiauctions, 2nd edition*. New York: W. W. Norton & Company (2020) ("Dealmaking") at 6-7.

the BATNAs can often be quantified to yield a "reservation value," that is, the minimum-willingness-to-take for a seller, or a maximum-willingness-to-pay for a buyer.[55] Given the BATNAs and reservation values, effective negotiators will then usually have at least a first-pass assessment, before they engage in negotiations, as to whether a zone of possible agreement ("ZOPA") exists.[56]

31. In my forthcoming book *Deals: The Economic Structure of Business Transactions*, my co-author and I offer a simple example of these concepts involving the sale of a used car, in which the BATNA for the seller (Sarah) is to sell the car to a dealership for $6,900, plus the option value for a better deal before the sale to the dealership (translating into a reservation price of $8,000 for the sale of her car); and the BATNA for the buyer (Jim) is to buy a newer car with lower mileage for $11,500 (translating into a reservation price of $9,000 for his purchase of Sarah's car). The analysis continues as follows:

> Sarah is willing to accept as little as $8,000, and Jim is willing to pay as much as $9,000. So … using the vocabulary of negotiations theory, there is a *zone of possible agreement*, or ZOPA between $8,000 and $9,000. In economics this is called the contract zone. If Sarah and Jim arrive at a price in that zone, they will be collectively better off by $1,000, compared to the

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55 *Id.* at 8.

56 *Id.* at 9-10.

> status quo of no deal, as of the time they are negotiating. The deal would create $1,000 in *joint value*.[57]

32. Our book continues with the point that simply because there is a ZOPA (and even if the parties are both aware that there is a ZOPA), there is no guarantee that the parties will reach a deal. The reason is that each side will use tactics (such as anchoring, bluffing, and posturing) in an effort to extract more of the ZOPA; but by doing so they risk no deal at all. We illustrate this point by returning to the used car negotiation:

> Because Sarah wants the highest price she can get, and Jim wants the lowest price, their attempts at strategic bargaining may result in no deal. Even if they reach a point at which they are negotiating in the range between $8,000 and $9,000, there is no guarantee that they will settle on a price. Sarah may reject $8,200, even though it is above her reservation price, because she thinks she can get $8,500. Or Jim might reject $8,500, even though it is lower than his reservation price, because he thinks he can get the car for $8,200. The two may give up and take their alternative deals without realizing they have a potential deal.[58]

33. This simple example illustrates a few core points from basic negotiation theory. First, the joint value created in any negotiation is a function of the parties' BATNAs. Therefore, the joint value created in a negotiation between Sarah and Jim is different from a negotiation between Sarah and (say) Bob, because Bob's

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57 Klausner, Michael and Guhan Subramanian. *Deals: The Economic Structure of Business Transactions.* Page Proofs. Harvard University Press, forthcoming ("Deals") at 7-8.

58 *Id.* at 9.

BATNA would be different from Jim's. Second, because the joint value is different, the outcome is likely to be different based on the counterparty. Specifically, Sarah will make offers and counteroffers based on her assessment of Jim or Bob's willingness-to-pay, which will be based on her assessment of their (different) BATNAs. Third, because of these dynamics, negotiation theory cannot predict with any great confidence where in the ZOPA the deal will end up. And fourth, the ZOPA can change if BATNAs change. Specifically, a ZOPA that may have existed at some point in time previously may not necessarily exist today, particularly where the conditions and factors impacting the ZOPA have changed considerably.

B. Single-Issue vs. Multi-Issue Negotiations

34. The field of negotiation initially focused on developing the theory and practice of pure price negotiations.[59] These negotiations were "fixed pie" because more for one side necessarily meant an equal amount less for the other side. The Nash bargaining model, which I have applied in my own research on M&A,[60] predicts that the parties each get half (~50 percent) of the ZOPA in these pure

59 *See, e.g.*, Karrass, Chester L. *Give and Take: The Complete Guide to Negotiating Strategies and Tactics*. United States: Crowell (1974).

60 Subramanian, Guhan. "Bargaining in the Shadow of Takeover Defenses." *Yale Law Journal* 113.3 (2003): 621-686.

price negotiations.[61] Assuming common knowledge and a $100 ZOPA, I explain this model as follows:

> In a Nash bargaining game, two players each request a certain amount of the surplus (here, $100). If their requests are compatible (i.e., summing to <= $100), each player receives the amount requested; if their requests are not compatible (i.e., summing to > $100), each player receives nothing. Assuming Pareto optimality, independen[ce] of irrelevant alternatives, symmetry, and invariance to positive linear transformations, the Nash bargaining game solution is that each player demands half of the surplus.[62]

35. Therefore, with no other information about the negotiation other than the magnitude of the ZOPA, a useful first approximation is that each side obtains half of the ZOPA in a fixed-pie negotiation.[63]

36. However, many real-world negotiations involve multiple issues, not just price. The field of negotiations has accordingly developed to study these more complicated negotiations as well.[64] The presence of multiple issues in the negotiation allows negotiators to make trades across issues – specifically,

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[61] *See* Nash, John. "Two-Person Cooperative Games." *Econometrica* 21.1 (1953): 128-140.

[62] Subramanian, Guhan. "Bargaining in the Shadow of Takeover Defenses." *Yale Law Journal* 113.3 (2003): 621-686 at 643 n. 105.

[63] Professor Barry Nalebuff (Yale School of Management) has advocated for the same split-the-ZOPA-evenly approach as a normative matter. Nalebuff, Barry. *Split the Pie: A Radical New Way to Negotiate*. Harper Business (2022).

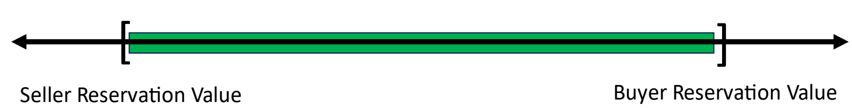
[64] *See, e.g.*, Raiffa, Howard. *The Art and Science of Negotiation*. Cambridge, Massachusetts: The Belknap Press of Harvard University Press (1982) at 131-132; Lax, David A. and James K. Sebenius. *The Manager as Negotiator*. New York: The Free Press (1986) at 30-33; Malhotra, Deepak and Max H. Bazerman. *Negotiation Genius*. New York: Bantam Dell (2008) at 50-52; Dealmaking at 22-26.

giving what is cheap to give, in exchange for receiving what is valuable to receive. For this reason, multi-issue negotiations create the possibility for value creation, or so-called "win win" negotiations. This stands in contrast to pure price negotiations, which are fixed-pie negotiations or sometimes called "win lose."

37. This distinction between fixed-pie and value-creating negotiations is well-established in the negotiation literature. While specific prescriptions among negotiation experts vary somewhat, there is general consensus around the idea that effective negotiators try to maximize the overall value of the deal and also capture an appropriate share for their side.

38. Visually, a pure price negotiation can be depicted by a straight line, with the reservation prices for each side demarcating the ZOPA as shown in **Figure 1**: *Pure Price Negotiation*.

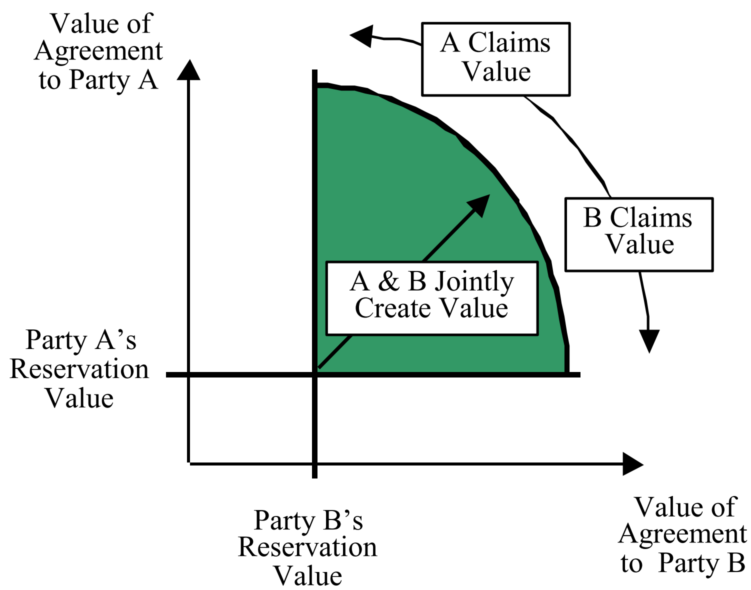
Figure 1: Pure Price Negotiation



39. In contrast, because of the possibility that both sides can be better off from trades, a multi-issue negotiation can only be depicted in a two-dimensional

way. In my teaching, for example, I often use the following diagram to depict the possible outcomes in a multi-issue negotiation. *See* **Figure 2**: *Multi-issue Negotiation*.

Figure 2: Multi-issue Negotiation



40. As shown in this diagram, the ZOPA in a multi-issue negotiation is no longer points along a line, but rather the entire shaded area. This means that the ability to predict the outcome is even more difficult in a multi-issue negotiation than in a single-issue (price) negotiation. While classical economic models of bargaining provide some traction in a price negotiation, these models do not readily translate to the multi-issue context. I provide implications of this point

for a hypothetical re-negotiation of the ALA between Arm and Qualcomm in Part VI below.

C. The Value Creation Role of CIC Provisions

41. CIC provisions are commonly used in many different contexts; licensing agreements, supply agreements, credit agreements, and employment agreements are just a few examples. CIC provisions give one or both parties certain rights in the event that a CIC occurs. In general, the business purpose is to provide a licensor with control over the manner and terms in which it does business with a counterparty.[65] For example, a licensing agreement will typically give the licensor the right to exit the agreement if the licensee experiences a CIC.[66] The basic idea is that a licensor should not be forced to provide a license to a future third party, for example, to a competitor, or expand the scope of an existing license to an existing counterparty, against its will or on terms that it does not agree with for that particular party. The CIC provision

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65 "Dear Negotiation Coach: Coping with a Change-of-Control Provision." *Harvard Program on Negotiation* (July 31, 2023). <https://www.pon.harvard.edu/daily/business-negotiations/dear-negotiation-coach-coping-with-a-change-of-control-provision-nb> (accessed Sept. 19, 2023) ("Change-of-control provisions are standard in long-term agreements, as they allow a party to avoid being forced to work with someone other than its agreed-upon counterpart.").

66 *See, e.g.*, Centocor/Schering-Plough Distribution Agreement (Apr. 3, 1998) § 8.2 (c), attached to Schering Plough Corp. *Form 10-K* (Feb. 26, 2004) ("Change in Control. If either party is acquired by a third party or otherwise comes under Control (as defined in Section 1.4 above) of a third party, it will promptly notify the other party not subject to such change of control. The party not subject to such change of control will have the right, however not later than thirty (30) days from such notification, to notify in writing the party subject to the change of Control of the termination of the Agreement taking effect immediately.").

does not necessarily mean that the license will not continue; but it gives the licensor the right to re-negotiate the terms on which the license will be given.

42. CIC provisions are a common way to protect against situations where an acquisition of a licensee would (1) dramatically change the scope of rights or obligations between the licensor and licensee, or (2) potentially be used by the acquiring company to bypass the licensor's licensing framework and gain access to licensed technology by acquiring the licensee.

43. By limiting the risk for contracting parties in ways that are relatively cheap to give and valuable to receive, CIC provisions can benefit both sides – a classic "win win" as described in the prior Part. For example, most credit agreements specify that the debt becomes due if there is a change in control of the borrower. This is because the creditor is granting credit to this specific borrower – and if the borrower subsequently becomes controlled by some other entity, the creditor's risk of default may increase. Research shows that the cost of capital is lower when there is a CIC provision in a credit agreement.[67] The intuition for

[67] *See, e.g.*, Crabbe, Leland. "Event Risk: An Analysis of Losses to Bondholders and 'Super Poison Put' Bond Covenants." *The Journal of Finance* 46.2 (1991): 689-706 at 689, 690 (finding that issuers received a 24 to 32 basis point discount when including a CIC control provision); Griffith, Sean J. and Natalia Reisel. "Dead Hand Proxy Puts and Shareholder Value." *University of Chicago Law Review* 84.3 (2017): 1027-89 at 1056 ("We find that inclusion of a Dead Hand Proxy Put reduces firms' borrowing costs in a manner that is both statistically and economically significant.").

this finding is that the creditor perceives less risk, and therefore can offer a lower cost of debt, because the CIC provision eliminates the possibility of having to extend credit to a future, higher risk, successor in interest to the borrower. In this way a CIC provision is a “win-win” between the parties.

44. When a CIC provision is a defined term, the parties will typically enumerate the events that trigger a CIC. Five types of events are often included in the definition of what constitutes a CIC:

1) the sale, disposition, or assignment of all or substantially all of the Company’s assets;

2) the consummation of a transaction in which any person or entity becomes the owner of more than 50 percent of the voting power of the Company (excluding any person or entity who currently owns such a stake);

3) the consummation of a transaction in which the current owners collectively own less than 50 percent of the new entity;

4) a change in board control, in which the incumbent directors or their approved successors do not constitute a majority of the board; or

5) the adoption of a plan that liquidates or dissolves the Company.

45. These triggers make conceptual sense because they capture the business purpose of a CIC provision, namely, to protect the parties against doing business with a counterparty against their will or on terms that they have not agreed to. Triggering the CIC provision may not necessarily mean that the

parties will terminate their agreement; but it forces a re-negotiation of the terms on which the parties will continue.

46. In some cases, the CIC provision contemplates this re-negotiation, and requires that the grantor cannot "unreasonably withhold" consent for the contract or license rights to be transferred. When this language exists, it weakens the grantor's ability to extract concessions in exchange for transferring the rights to the new owner. Other CIC provisions do not constrain the grantor's consent obligation in this way. When the "unreasonably withheld" language is absent, the grantor has a stronger hand in the re-negotiation with the new owner.

D. The Business Role of CIC Provisions in IP Licensing Agreements

47. CIC provisions are particularly common, if not ubiquitous, in IP licensing agreements. Licensors need to protect their IP as it represents their source of revenue, and uncontrolled usage is likely to dilute or reduce additional revenue sources. CIC provisions and anti-assignment provisions allow licensors to control if and how their IP is used by companies with whom the licensor did not originally negotiate. Without such provisions, an agreement originally negotiated with one company may end up allowing an entity to use the licensor's IP without negotiating its own contract terms. In an acquisition scenario, the acquiring company may also be much larger than the original licensee and seek to use the IP on a larger scale and in a different manner than

was originally bargained for. These mismatches between the original negotiating context and the ultimate use create inefficiency; in general, a deal that does not accurately reflect the desires of both parties who are bound to it will not maximize the total surplus that could be claimed between the parties.

48. To effectuate the CIC provisions, licensors may include an option for contract termination, and/or a contract may have a general termination provision conditioned upon certain triggers such as a breach of terms by the other party.[68] Termination provisions provide protection for the licensor should it decline to consent to a change in control of its licensee.[69] Writing in an option for contract termination allows the licensor in a licensing agreement to have a "no deal" alternative should negotiation with a new acquiring entity fail. Without this BATNA, the licensor will have no credible walk away option and the prospective licensee, knowing this fact, may extract all of the value from any renegotiation, or refuse to negotiate entirely.[70]

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68 *See, e.g.*, "Termination Clauses." *LexisNexis*. <https://www.lexisnexis.com/supp/largelaw/no-index/coronavirus/commercial-transactions/commercial-transactions-termination-clauses.pdf> (accessed Sept. 11, 2023) (giving examples of differently conditioned termination clauses, including upon change of control).

69 Deals at 113 ("From the narrow perspective of one party, there is often value in having an unconditional right to terminate when a deal is no longer beneficial. In a long-term supply contract, for example, a buyer may want freedom to stop making purchases if it no longer needs what is being supplied, or if it finds a better deal elsewhere.").

70 Dealmaking at 165-67 (explaining how, to execute a "shut-down move" in a negotiation, such as threatening to terminate a contract if an offer or term is not accepted, the threat must be

49. It also may make sense, from a business perspective, for a termination provision to require a licensee to destroy or discontinue the use of all derivative work based on the licensor's IP upon contract termination and to confirm that the licensee has indeed destroyed all such work. Without such a clause, the licensor risks the licensee continuing to use the derivative work to further future R&D efforts (on an unlicensed basis), despite that work being (definitionally) the originally licensed IP. The licensee would essentially be permitted free use of the licensor's technology: the licensee would get the core technology under the original license, build a derivative, and then pay no royalties on the derivative. An entity that subsequently acquires the licensee and its derivative technology would then be able to extract the value that the licensor would have gained through the derivative. IP negotiations thus need to address the use of derivative work based on the licensor's IP to avoid such a scenario where entities could constantly change royalty rates through acquisitions of licensees conducted with the licensor's consent. Such a provision covering derivative work, while undeniably favorable to the licensor, nonetheless reflects an intentional outcome of the negotiation process based on important business objectives.

"credible"), 24 ("If we are fully forthcoming about our interests, the other side can use this information to extract all of the value that is created. … The core of the problem is this: in order to identify value-creation opportunities in a negotiation we need to disclose information; but disclosing information can expose us to value-claiming tactics by the other side.").

50. A termination provision requiring destruction of all derivative work based on the licensor's IP upon contract termination may also make business sense for entities that have large licensing ecosystems and that rely on strong enforcement mechanisms to keep licensees in line. If the licensor allowed a licensee to breach its license agreement without imposing consequences for such a breach, other licensees may engage in similar behavior or attempt to use the licensee's breach (and lack of consequences) to negotiate for more favorable terms.

IV. APPLICATION TO ARM-NUVIA ALA

A. Arm Entered into a Limited Number of ALA Contracts and Each Was Separately Negotiated.

51. Most of Arm's licensing agreements are TLAs, not ALAs.[71] Arm has entered into ALAs with approximately fifteen entities,[72] in contrast to its hundreds of other, non-ALA licensees and thousands of contractual licensing agreements.[73] The significant support required from Arm for ALA licensees' development efforts and the fact that most companies do not have the capabilities to design custom CPUs and instead buy off-the-shelf CPUs (available from Arm and

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71 Segars Dep. 31:2-4.

72 Manners, David. "ARM Adds an Architectural Licensee." *Electronics Weekly* (Apr. 21, 2015). <https://www.electronicsweekly.com/news/business/finance/arm-adds-architectural-licensee-2015-04> (accessed Sept. 11, 2023).

73 Complaint ¶ 14.

other chip design companies) contribute to the relative infrequency of these types of agreements.[74]

52. Because of the significant investment that each of these handful of ALA deals requires from Arm and its licensees, the ALA terms are subject to careful review and negotiation. As a matter of custom in transactional practice, internal specialists in the underlying technology, assisted by inside and outside counsel, would carefully review the ALAs. Indeed, even if the licensee chose not to deviate from initial terms proposed by Arm at the onset of the negotiations, it is standard business practice for all contracts, especially such high profile and customized ones, to be carefully reviewed to ensure that they reflect the full and accurate business intentions of the parties.[75] There are additionally legitimate business reasons to expect that Arm's ALAs were subject to individualized negotiations, including the relative infrequency with which they were entered into and the highly customized nature of the work that each would

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[74] Segars Dep. 43:10-44:19, 51:16-52:24, 191:2-193:18. *See also* Complaint ¶ 18.

[75] [redacted]

encompass, in contrast to a TLA that might provide for simple incorporation of an "off-the-shelf" Arm design.[76]

53. Given this expectation, under reasonable business custom and practice, specific licensing agreement provisions, such as the particulars of the termination clause and CIC provisions, would have represented the negotiated intentions of both of both licensor and licensee. Given the timeline of negotiating Nuvia's ALA discussed in Part II above, I conclude that, under reasonable business custom and practice, [redacted]

54. [redacted]

[redacted]

[76] Abbey Dep. 75:22-76:4; Complaint ¶ 17.

[77] [redacted]

55. According to business custom and practice, the inclusion of such a specific and clear provision would not have been accidental, particularly in light of the extensive editing and redlining and multiple meetings involved in the negotiation process.[78] [redacted]

56. Further, my analysis of the Qualcomm ALA alongside Nuvia's ALA, which will be discussed in the next section, shows that [redacted]

57. Importantly, [redacted]

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78 [redacted]

[redacted]

B. Arm Negotiated Different Provisions with Nuvia and Qualcomm.

58. I analyzed the terms of both the Qualcomm and the Nuvia ALAs and their appendices and found that, in terms of economics and negotiations, they reflect the different business objectives of Qualcomm and Nuvia.

59. While much of the language appears similar, I found that key provisions were different or unique to one agreement or the other, from the basics of contract term to the complexities of the fees and CIC provisions. For example, [redacted]

[79] Nuvia ALA at ARM_00059196; Architecture License Agreement ("ALA") Between Arm Limited and Qualcomm Global Trading Pte, Ltd. (May 30, 2013) (ARM_00044650 at ARM_00044675) ("Qualcomm ALA").

[redacted]

60. [redacted]

61. [redacted]

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80 Qualcomm ALA at ARM_00044675.

81 *Id.* at ARM_00044677; Nuvia ALA at ARM_00059197.

82 Qualcomm ALA at ARM_00044675-76; Nuvia ALA at ARM_00059196-97.

[redacted]

62. [redacted]

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83 Qualcomm ALA at ARM_00044675-76.

84 Nuvia ALA at ARM_00059196; Qualcomm ALA at ARM_00044676.

[redacted]

63. The uniqueness of these contracts, as well as their individualized provisions, indicates that each was the product of negotiations between the parties and Arm, and as such, each reflects the deliberate intentions and expectations of Qualcomm or Nuvia, respectively. Testimony taken from parties involved in negotiations also confirms this. [redacted]

85 [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted] [redacted]

[redacted]

[redacted]

[redacted]

89 [redacted]

[redacted]

64. [redacted]

65. [redacted]

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91 [redacted]

Table 1: Example Differences Between the Qualcomm and Nuvia Agreements

[redacted]

66. These differences are entirely consistent with the negotiation theory described in Part III. Negotiators will adjust their negotiation tactics and strategy based on the perceived BATNA of the counterparty. For example, a licensee that

intends to use Arm's technology for a more lucrative market may justify more favorable terms compared to a licensee who is pursuing a more commoditized, lower margin market. In this case, it is highly likely, in my opinion, that Arm perceived a different BATNA for each of Nuvia and Qualcomm, which in turn would yield a different ZOPA in the two different negotiations, which then (as summarized in Table 1) yields different ALAs.

V. APPLICATION TO QUALCOMM'S ACQUISITION OF NUVIA

A. Due Diligence Typically Involves an Examination of License Agreements.

67. As a matter of standard transactional practice, Qualcomm reasonably should have been aware of the [redacted] when it agreed to acquire Nuvia. As I described in Part III.C above, [redacted] are common in corporate contracts. As a large and sophisticated enterprise with extensive experience with IP licensing and contract negotiation, including with Arm,[92] Qualcomm should have reasonably known of the possibility of such provisions existing in Nuvia's contracts, and of their resulting implications.

[92] Complaint ¶ 26.

68. Consistent with this conclusion, I analyzed a collection of Arm ALAs provided to me in this matter and found that: (i) each contract reflected a unique agreement, but (ii) CIC or anti-assignment provisions were a standard inclusion across the contracts. For example, [redacted]

> [redacted]

69. Similarly, the ALA between Arm and [redacted] includes detailed CIC and anti-assignment contingencies that [redacted] The results of my

93 [redacted]

[redacted]

review of these and other contracts reflect the reality that such provisions are commonplace protective measures that may be negotiated for in IP licensing agreements.[95]

70. Even if, *arguendo*, Qualcomm was not generally aware of the CIC provisions in the ALAs, [redacted] As a matter of standard corporate practice, an important component of the due diligence process is to analyze the target company's contracts and agreements, especially those pertaining to IP, for any relevant provisions that could impact their transferability in a merger or acquisition.[97] Similarly, once

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95 [redacted]

96 [redacted]

97 Robins, Martin B. "Intellectual Property and Information Technology Due Diligence in Mergers and Acquisitions: A More Substantive Approach Needed." *Journal of Law, Technology and Policy* (2008): 321-356 at 328-29 ("Since M&A transactions and macroeconomic turmoil can have a major impact on the viability of licensors and licensees, it is also prudent to address the termination provisions of any major license agreements to which

aware, [redacted]

71. Similarly, my review of Arm's ALAs found that termination provisions were commonplace, and generally involved the requirement that the licensee

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the target is a party to determine what circumstances allow for termination. For example, if there is a "change of control" of the licensor, or if the licensor's circumstances drastically deteriorate, or merely for the licensor's own convenience."); Börzsönyi, Blanka. "Intellectual Property Considerations in M&A Due Diligence." *Annales Universitatis Scientiarum Budapestinensis de Rolando Eötvös Nominatae* 58 (2019): 89-99 at 96 ("Counsel must also understand how the Target IP has been developed or acquired[.] … In the case of acquired IP, the assignment provisions of the relevant agreements must be double-checked to ensure that the transfer of ownership has been completed, without any additional conditions or obligations. A core area of review is the IP [licenses] concluded by the Company[.] … IP counsel should normally try to identify… any post-termination restrictions; … e.g., in the case of stock purchases and forward or reverse mergers change-of-control or anti-assignment provisions may be triggered[.]").

98 [redacted]

[redacted] or substantially similar language.[100] It is reasonable for Arm to have negotiated for such a protection to prevent unauthorized and unsupervised use of its IP, and Qualcomm's due diligence and acquisition bidding should have incorporated the possibility that Arm

99 [redacted]

100 [redacted]

would trigger the provision if a renegotiated deal over the Nuvia licenses could not be completed.

B. Qualcomm and Nuvia Seemed to be Aware of the [redacted]

72. Consistent with customary transactional practices and my conclusions in the prior Part, my review of the record indicates [redacted]

101 [redacted]

[redacted] [redacted]

[redacted] [redacted]

73. [redacted]

74. [redacted]

[104] [redacted]

[105] Defendants' Answer and Defenses to Plaintiff's Complaint and Jury Demand and Defendants' Counterclaim. *Arm Ltd. v. Qualcomm Inc., Qualcomm Technologies, Inc., and NuVia, Inc.* (D. Del. No. 22-01146) (Sept. 30, 2022) ("Counterclaim") ¶¶ 189, 204.

[106] [redacted] Counterclaim ¶¶ 205-210.

[107] Counterclaim ¶ 190 (emphasis added); [redacted]

75. Taken together, Qualcomm's initial communications show that it anticipated needing both Arm's consent as well as potential new agreements, including potentially new annexes, in order to continue developing Nuvia's innovations based on Arm's IP, and that it did not expect Qualcomm's ALA and TLA to cover its use and development of Nuvia technology that was based on Arm's IP under the Nuvia-Arm ALA.

76. In my opinion, Qualcomm's stated position is consistent with the transfer of rights and assets during acquisitions. It is inconsistent with Qualcomm's assertions elsewhere that the "assignment provisions are inapplicable to Qualcomm's acquisition of NUVIA because Qualcomm has its own separate license agreements with ARM, which covered NUVIA and its technology as soon as the acquisition closed."[108]

C. Qualcomm Did Not Negotiate for Nuvia to Obtain Arm's Consent.

77. Qualcomm could have negotiated for contractual commitments that would have reduced its exposure to the [redacted] with Arm. However, Qualcomm's acquisition of Nuvia closed without Nuvia obtaining Arm's consent for transfer of Nuvia's ALA. I infer from this that Qualcomm assumed the risk that Arm would not consent for the transfer of the ALA.

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[108] Counterclaim ¶ 201.

VI. APPLICATION TO THE [redacted] IN THE ARM-NUVIA ALA

A. The [redacted] in the Arm-Nuvia ALA Are Consistent with Business Considerations, Negotiation Theory and Case Studies.

78. [redacted]

79. Real-world cases support this conclusion. Consider Disney which, on the cusp of launching its streaming service Disney+, elected not to renew its licensing

[109] Deals at 88 ("In some situations, for an exchange to take place between two parties, one or both must make an *asset-specific investment* (or, equivalently, a *relationship-specific investment*). This is an investment whose value is dependent on the cooperation of another party; it would have a substantially lower value, and perhaps no value, outside the relationship with that party.") (italics in original) (citations omitted).

agreement with Netflix. As a result, Disney content was removed from Netflix and Netflix lost its rights to stream future Disney movies.[110]

80. *SQL Solutions v. Oracle Corp.* also illustrates this principle.[111] In this case, D&N Systems Inc. held a perpetual, non-exclusive license from Oracle Corp. to use certain Oracle software. Under the agreement, the rights to D&N were exclusively for its use and were not to be assigned or transferred to a third party without written permission from Oracle. In January 1990, Sybase, an Oracle competitor, bought D&N Systems using a reverse merger structure (i.e., leaving the D&N corporate shell intact). Oracle then withdrew from the licensing agreement with D&N, claiming that a "transfer of rights" occurred when Sybase acquired D&N. Sybase/D&N brought suit seeking injunctive relief, claiming no such transfer of rights took place because the D&N corporate shell remained unchanged. The District Court ruled for Oracle, finding that a "transfer of rights" did take place notwithstanding the reverse merger

110 Robehmed, Natalie. "Disney to End Distribution Agreement with Netflix, Launch Streaming Service." *Forbes* (Aug. 8, 2017). <https://www.forbes.com/sites/natalierobehmed/2017/08/08/disney-to-end-distribution-agreement-with-netflix-as-it-prepares-own-streaming-service/?sh=7486af462a98> (accessed Dec. 14, 2023); Castillo, Michelle. "Disney Will Pull Its Movies from Netflix and Start Its Own Streaming Services." *CNBC* (Aug. 8, 2017). <https://www.cnbc.com/2017/08/08/disney-will-pull-its-movies-from-netflix-and-start-its-own-streaming-services.html> (accessed Dec. 14, 2023).

111 *SQL Solutions, Inc. v. Oracle Corp.*, 1991 WL 626458 (N.D. Cal. 1991).

structure.[112] I explain to my students that this case illustrates the general point, that "[u]nder basic equitable principles, a company should not be forced, in effect, to license its intellectual property to a competitor."[113]

81. Further, it is reasonable and standard that terminations occur *even if* one party will lose the benefit of its investments or improvements. For example, when Starbucks terminated a licensing agreement with Kraft Foods, Kraft could no longer distribute Starbucks coffee despite Kraft having made significant investment in developing Starbucks' retail presence for over a decade.[114] Indeed, in anticipation of the large loss that Kraft would suffer if Starbucks terminated the license arrangement—and consistent with negotiation principles—Kraft negotiated with Starbucks for a specified buyback process that involved a 35 percent sale premium.[115]

82. In another case Hewlett-Packard ("HP") had a licensing partnership with Beats Electronics wherein HP invested to integrate Beats Audio technology into its

112 Subramanian, Guhan and Rhea Ghosh. "Remicade/Simponi: Legal Memorandum." *HBS Case Study N9-911-046* (July 13, 2012) at 3-4.

113 *Id.* at 4.

114 Reily, Stephen. "Starbucks, Kraft and the $2.7 Billion Divorce." *IMC Licensing* (Dec. 23, 2013). <https://imclicensing.com/starbucks-kraft-and-the-2-7-billion-divorce> (accessed Dec. 15, 2023).

115 *Id.*

products, particularly its high-end PCs.[116] When Apple, an HP competitor, acquired Beats Electronics, HP was required to phase out its Beats integration plans, despite the previously existing partnership.[117] Such consequences are a natural and logical conclusion of CIC and termination provisions that are needed to make asset-specific investments.[118]

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116 Reardon, Marguerite and Shara Tibken. "The Beats Go On at HP (at Least Until 2015)." *CNET* (May 28, 2014). <https://www.cnet.com/tech/computing/the-beats-go-on-at-hp-at-least-until-2015> (accessed Dec. 15, 2023).

117 *Id.*; Keizer, Gregg. "HP Must Give Up Beats Audio After Apple Deal." *Computerworld* (May 29, 2014). <https://www.computerworld.com/article/2489984/hp-must-give-up-beats-audio-after-apple-deal.html> (accessed Dec. 15, 2023).

118 Numerous other cases support the conclusion that it is reasonable and standard for CIC and termination provisions to require discontinuance of use even if it results in lost benefit of investments or improvements. For instance, Target had long term licensing agreements with the brands Cherokee, Circo, Mossimo, and Merona, but when those agreements were not renewed, Target not only lost the rights to sell those branded products but gave up all the investments it had made in brand value, promotion, and customer loyalty associated with brands. *See* Ziobro, Paul. "Target Won't Renew U.S. License for Cherokee Brand." *The Wall Street Journal* (Sept. 10, 2015). <https://www.wsj.com/articles/target-wont-renew-u-s-license-for-cherokee-brand-1441919400> (accessed Dec. 15, 2023); Kumar, Kavita. "Target Is Shedding Merona and Mossimo and Adding New Brands Instead." *Los Angeles Times* (Aug. 21, 2017). <https://www.latimes.com/business/la-fi-target-merona-mossimo-20170821-story.html> (accessed Dec. 15, 2023). As another example, Tesco, a supermarket chain, discontinued a streaming service it offered, Blinkbox. Upon that discontinuation, Tesco lost use of the content licenses it had acquired from Disney, despite having made significant investments in developing digital streaming and promoting usage of those licenses. *See* "Tesco's Blinkbox Starts Carrying Disney Movies." *Washington Times* (Apr. 4, 2012). <https://www.washingtontimes.com/news/2012/apr/4/tescos-blinkbox-starts-carrying-disney-movies> (accessed Dec. 15, 2023); Thomson, Amy. "Tesco Abandons Video-Streaming Ambitions in Blinkbox Sale." *Bloomberg* (Jan. 8, 2015). <https://www.bloomberg.com/news/articles/2015-01-08/tesco-abandons-video-streaming-ambitions-in-blinkbox-sale?embedded-checkout=true> (accessed Dec. 15, 2023); Brian, Matt. "Tesco Has Given Up on Blinkbox." *AOL* (July 19, 2019). <https://www.aol.com/news/2015-01-26-tesco-gives-up-on-blinkbox.html> (accessed Dec. 15, 2023).

83. Arm's ALAs limit the license to [redacted] delivered under that particular license, regardless if similar or identical [redacted] is licensed to another entity under a different license. For example, in the Qualcomm ALA, [redacted] [redacted] And Section [redacted] of the Qualcomm ALA [redacted] [redacted]

84. Arm's treatment of its licensees as separate from each other is consistent with negotiation theory and important business considerations. As described in Part III.A, negotiation theory predicts that Arm would negotiate differently with its various ALA counterparties, based on Arm's perception of the counterpart's BATNA (and therefore the ZOPA for the negotiation). Indeed, the evidence provided in Part IV confirms that Arm did in fact negotiate different ALAs with different counterparties. If there could be leakage from one ALA to another,

119 [redacted]

due to an un-enforced or under-enforced CIC provision, Arm would need to negotiate based on a lowest-common-denominator perceived BATNA among all its existing and possible counterparties. This one-size-fits-all negotiation approach would shrink the ZOPA, possibly creating a no-ZOPA situation even though a ZOPA would exist in each of the tailored negotiations with individual counterparties. The result would be a significant social welfare loss compared to the situation where Arm could negotiate tailored agreements with counterparties that are protected by CIC provisions that effectively silo the ALAs.

85. [redacted]

86. To summarize, negotiation theory and important business considerations dictate that a licensor should be able to keep its licensees separate from each other using separate license agreements. [redacted]

Arm keeps each of its ALA licenses separate from each other and maintains control of its licensing model through its CIC and termination provisions that require discontinuance of use and return or destruction of information. If Arm's licensees were allowed to assume the benefit of another entity's license (especially if the latter's license provided for lower royalty rates), Arm's entire business model would be severely threatened.

87. Keeping licensees and customers separate is a common business practice. For example, Microsoft has different retail licensing terms (e.g., governing capacity, cost, etc.) based on whether a customer is a government organization, educational entity, or a non-profit, as well as based on institution size.[121] Similarly, Adobe offers different licensing for businesses (large enterprise companies vs. small to midsize), government, and educational institutions that differ in terms of management, billing, and other factors.[122] In general, for

[121] "Licensing Options for Industries—Government." *Microsoft*. <https://www.microsoft.com/en-us/licensing/licensing-programs/licensing-for-industries?activetab=licensing-for-industries-pivot:primaryr2> (accessed Dec. 15, 2023); "Licensing Options for Industries—Education." *Microsoft*. <https://www.microsoft.com/en-us/licensing/licensing-programs/licensing-for-industries?activetab=licensing-for-industries-pivot:primaryr3> (accessed Dec. 15, 2023); "Licensing Options for Industries—Nonprofit." *Microsoft*. <https://www.microsoft.com/en-us/licensing/licensing-programs/licensing-for-industries?activetab=licensing-for-industries-pivot:primaryr4> (accessed Dec. 15, 2023).

[122] Foxen, David. "Adobe Licensing Quick Guide." *ITA Asset Management*. <https://www.itassetmanagement.net/wp-content/uploads/2014/07/Adobe-Licensing-Quick-Guide.pdf> (accessed Dec. 15, 2023); Pourhadi, Soroush. "Adobe Licensing Guide." *vScope* (Aug. 12, 2019). <https://www.vscope.net/blog/adobe-licensing-guide> (accessed Dec. 15, 2023).

companies where licensing technology is critical, siloed licenses permit customer segmentation, which is a marketing tool that is taught at virtually every business school in the world.

B. Terms That Were Considered and/or Offered Previously for a Re-negotiated License Cannot Simply Be Adopted Later.

88. In the but-for world in which Qualcomm did not allegedly breach its contractual obligations to Arm, the two parties would possibly have arrived at new licensing agreements through a renegotiation process.[123] However, the potential terms and amounts considered and/or offered by Arm previously during such a process are not necessarily appropriate later in time, particularly where the conditions and factors impacting such terms and amounts have changed considerably. This is especially true here where the original ALA between Qualcomm and Arm was entered into on September 29, 2003, and the Amended and Restated ALA was entered into on May 30, 2013, many years before Arm and Nuvia entered into their ALA.[124] Given the passage of time, there is no reason to think that Arm would have been willing to grant the same terms it provided Qualcomm to Nuvia. Given the business environment and ecosystem

123 [redacted]

[redacted]

in which Arm and its competitors operate, the terms and amounts that the parties may have considered at some point in time in the past may no longer be appropriate with the passage of time and cannot simply be adopted at some point in the future.

89. In terms of negotiation theory, it is well understood that BATNAs can shift over time, which then shifts the ZOPA, which in turn affects negotiation tactics and strategy, which in turn affects negotiation outcomes. The terms that the parties would have possibly achieved at one point in time do not have predictive power for a subsequent point in time, if BATNAs or perceived BATNAs have changed.

C. Predicting the Outcome of a Renegotiated ALA Would Be Extremely Difficult.

90. Given that Qualcomm should have known about the [redacted] Nuvia's licenses to Qualcomm upon its acquisition of Nuvia, Qualcomm could have renegotiated Nuvia's licenses with Arm. Consistent with the prediction, Arm attempted to "negotiate[] with Qualcomm" for "more than a year" in order to "reach an agreement regarding Qualcomm's unauthorized acquisition of

Nuvia's 'in-process technologies' and license," but was unable to reach an agreement.[125]

91. Given the complexities of this deal, predicting exactly how the deal would turn out within the ZOPA even prior to this lawsuit, and without the attendant publicly from the lawsuit, would be extremely difficult. This is particularly true here because a hypothetical re-negotiation would involve dozens of important issues (and many more less critical issues). Part III.B describes why predicting the result of a multi-issue negotiation is even more difficult than predicting the outcome of a single-issue price negotiation. For these reasons, quantitative analysis of this hypothetical would need to factor in many considerations and be subject to a large amount of uncertainty, making it difficult to assess the value of the outcome in dollar terms from Arm's perspective. In addition, any such quantitative analysis would not cover what is perhaps the most significant harm at issue here: the harm to Arm's reputation and its licensing ecosystem.[126]

[125] Complaint ¶ 37. *See also* [redacted]

[126] [redacted]

92. The ZOPA that may have existed previously, moreover, may no longer exist currently due to substantial changes since the parties attempted to negotiate a resolution of Qualcomm's acquisition of Nuvia and its failure to obtain consent to the assignment of Nuvia's ALA. For example, while the parties previously were negotiating only as to the benefit that would accrue to Qualcomm (i.e., the assignment of the Nuvia ALA and Qualcomm's use of Nuvia's technology developed using Arm's technology and IP under the Nuvia ALA), any such negotiation now would need to consider the harm to Arm given the public defection and breach of Arm's largest partner (Qualcomm), the impact of Qualcomm's breach on other ALA licensees and potential licensees, the potential for other ALA licensees to seek more favorable terms for themselves in view of Qualcomm's breach, and the potential for other ALA licensees to take more extreme negotiating positions given Qualcomm's breach. These factors did not exist at the time of the prior negotiation.

D. Non-Enforcement Could Have Negative Follow-On Effects That Are Impossible to Quantify.

93. Any commercial negotiation must be considered in the broader business context. In this case, Arm is part of the wider processor and chip industries and maintains business and licensing relationships with hundreds of companies, including other large players such as Apple, Microsoft, Marvell, and

Samsung.[127] Arm has also invested significantly in creating an entire ecosystem for its products, comprised of upstream IP and downstream partners and manufacturing processes.

94. Allowing noncompliance with Arm's licenses would erode authority over Arm's IP.[128] If, in the hypothetical world with a renegotiated deal between Arm and Qualcomm, Qualcomm were allowed to continue developing technology created under the Nuvia-Arm ALA, this would send a signal to the market and to Arm's other partners that Arm would not (or could not) enforce its contractually negotiated termination, change in control provisions, or other IP protections.[129] Arm's other licensees would take note and conclude that the CIC

[127] Complaint ¶ 14; Manners, David. "ARM Adds an Architectural Licensee." *Electronics Weekly* (Apr. 21, 2015). <https://www.electronicsweekly.com/news/business/finance/arm-adds-architectural-licensee-2015-04> (accessed Sept. 11, 2023).

[128] [redacted]

[129] [redacted]

and termination provisions of their own agreements have no teeth.[130] These licensees may also follow Qualcomm's behavior and bypass Arm's licensing model by acquiring other ALA licensees to gain the benefit of the technology licensed under that separate license. In negotiation analytic terms, the perceived BATNA of *all* of Arm's customers and potential customers would change, to Arm's disadvantage.

95. This effect would be magnified by the fact that Qualcomm is a large partner, comprising as much as 34 percent of the Arm-based mobile computing chip market.[131] Several other companies comprise large shares as well, including Apple.[132]

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130 [redacted]

131 "Strategy Analytics: Headline: Qualcomm, Apple and MediaTek Dominate the Arm-based Mobile Computing Chip Market." *Business Wire* (June 16, 2022). <https://www.businesswire.com/news/home/20220616005125/en/Strategy-Analytics-Headline%C2%A0Qualcomm-Apple-and-MediaTek-Dominate-the-Arm-based-Mobile-Computing-Chip-Market> (accessed Sept. 11, 2023). *See also* Segars Dep. 12:16-13:1.

132 "Strategy Analytics: Headline: Qualcomm, Apple and MediaTek Dominate the Arm-based Mobile Computing Chip Market." *Business Wire* (June 16, 2022). <https://www.businesswire.com/news/home/20220616005125/en/Strategy-Analytics-Headline%C2%A0Qualcomm-Apple-and-MediaTek-Dominate-the-Arm-based-Mobile-Computing-Chip-Market> (accessed Sept. 11, 2023).

96. If Arm was not able to enforce its termination provisions and require Qualcomm to destroy the Arm confidential information that was used in the Nuvia technology, it is therefore possible that Arm would suffer reputational consequences and other follow-on effects related to the perception of Arm's inability to enforce the very terms of its licenses. Any analysis of the impact of potential future renegotiations must include an analysis of the impact of this market signal.

97. It is also possible that continued noncompliance or a renegotiated deal could impact Arm's ventures into upstream or downstream markets. For example, a future merger with a downstream computing company could be frustrated by the reputational impact of companies assuming that Arm's upstream IP cannot be protected, which reduces Arm's financial value. The interconnected nature of Arm's partners and product ecosystem means that non-enforcement of its licensing agreement terms could have far-reaching implications.

98. Allowing Qualcomm to ignore its contractual obligation to destroy and discontinue use of Nuvia-licensed Arm IP could also competitively disadvantages Arm's partners. For example, [redacted]

[redacted]

99. The threat to Arm's business model and the harm Arm would suffer is further supported by the testimony of Arm's current CEO, Rene Haas. Mr. Haas testified that [redacted] Mr. Haas further testified [redacted][136] He also emphasized the risks of signaling to the market that Arm could not protect its IP:

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133 [redacted]

[redacted] [redacted]

135 [redacted]

[redacted] [redacted]

[redacted]

100. Other testimony from current and former Arm personnel highlights the importance of Arm's business model and the effect of Qualcomm and Nuvia's actions on the Arm ecosystem. Will Abbey, Arm's Chief Commercial Officer, testified that [redacted][138] Former CEO Simon Segars also testified that [redacted]

137 [redacted]

[redacted]

[redacted]

101. All of these effects represent real economic damages to Arm. However, in my opinion, these effects would be virtually impossible to quantify.

102. I understand that Qualcomm may submit expert testimony regarding the impact to Qualcomm if the termination provisions of the Nuvia ALA were enforced. I reserve the right to fully address any such expert testimony in a rebuttal or reply report.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct. Executed this 20th day of December 2023 in Noord, Aruba.

Guhan Subramanian

Appendix A

Curriculum Vitae

Guhan Subramanian

Hauser 314
Harvard Law School
Cambridge, MA 02138

Baker Library 473
Harvard Business School
Boston, MA 02163

Academic Positions Held

H. Douglas Weaver Professor of Business Law, Harvard Business School, 2007-Present

Joseph Flom Professor of Law and Business, Harvard Law School, 2004-Present

Faculty Chair, JD/MBA Program, Harvard University, 2004-Present

Faculty Chair, Program on Negotiation, Harvard Law School, 2018-Present

H. Douglas Weaver Visiting Professor of Business Law, Harvard Business School, 2006-07

Joseph Flom Assistant Professor of Law and Business, Harvard Law School, 2002-2004

Assistant Professor of Business Administration, Harvard Business School, 2001-2002

Lecturer in Business Administration, Harvard Business School, 1999-2001

Education

J.D., *magna cum laude*, Harvard Law School, 1998. Moot court competition winner. Editor, Harvard Law Review.

M.B.A., Harvard Business School, 1998.

A.B., *magna cum laude* (Economics), Harvard University, 1992. Phi Beta Kappa. Elected undergraduate student government president.

Books

Deals: The Economic Structure of Business Transactions (forthcoming Harvard University Press 2024) (with Michael Klausner)

Dealmaking: The New Strategy of Negotiauctions (2^{nd} ed. 2020)

Corporate Law (2017) (with Holger Spamann)

Commentaries and Cases on the Law of Business Organization (4th ed. 2012) (with William T. Allen & Reinier Kraakman)

Dealmaking: The New Strategy of Negotiauctions (2011)

Commentaries and Cases on the Law of Business Organization (3rd ed. 2009) (with William T. Allen & Reinier Kraakman)

Commentaries and Cases on the Law of Business Organization (2nd ed. 2007) (with William T. Allen & Reinier Kraakman)

Academic Articles

Pills in a World of ESG and Activism, 1 *University of Chicago Business Law Review* 417 (2022) (with Caley Petrucci)

Freezeouts in Delaware and Around the World, 24 *University of Pennsylvania Journal of Business Law* 803 (2022)

Deals in the Time of Pandemic, 121 *Columbia Law Review* 1405 (2021) (with Caley Petrucci).

Sources of Power in Public Negotiations: A Framework Applied to Public-Public and Public-Private Negotiations, *Negotiation Journal*, (2020) (with Brian Mandell and Stephen Petraeus).

Go-Shops Revisited, 133 *Harvard Law Review* 1215 (2020) (with Annie Zhao). Selected by academics as one of the “top ten” articles in corporate/securities law for 2020, out of 323 articles published in that year.

Appraisal After Dell, in *The Corporate Contract in Changing Times: Is the Law Keeping Up?* (University of Chicago Press 2019).

The Effect of Prohibiting Deal Protection on M&A Activity: Evidence from the United Kingdom, 60 *Journal of Law & Economics* 1 (2017) (with Fernan Restrepo).

The New Look of Deal Protection, 69 *Stanford Law Review* 1013 (2017) (with Fernan Restrepo).

Deal Process Design in Management Buyouts, 130 *Harvard Law Review* 590 (2016). Selected by academics as one of the “top ten” articles in corporate/securities law for 2017, out of more than 565 articles published in that year.

Freezeouts: Doctrine & Perspectives, M&A HANDBOOK (Claire Hill & Steven Davidoff Solomon, eds.) (2016) (with Fernan Restrepo).

The Effect of Delaware Doctrine on Freezeout Structure and Outcomes: Evidence on the Unified Approach, 5 *Harvard Business Law Review* 205 (2015) (with Fernan Restrepo).

Corporate Governance 2.0, *Harvard Business Review* (March 2015).

Delaware's Choice, *Delaware Journal of Corporate Law* 39, no.1 (Nov. 2014). Delivered as the 29th Annual Francis G. Pileggi Distinguished Lecture in Law in Wilmington, Delaware in November 2013. Selected by academics as one of the "top ten" articles in corporate/securities law for 2014, out of more than 525 articles published in that year

Delaware's Choice: A Brief Reply to Symposium Commentators, *Delaware Journal of Corporate Law* 39, no.1 (Nov. 2014).

Does Shareholder Proxy Access Improve Firm Value? Evidence from the Business Roundtable Challenge, *Journal of Law & Economics* 56 no.1 (Feb. 2013) (with Bo Becker and Dan Bergstresser).

Improving Director Elections, *Harvard Business Law Review* (Fall 2012) (with Bo Becker).

A New Era for Raiders, *Harvard Business Review* (Nov. 2010).

Is Delaware's Antitakeover Statute Unconstitutional? Evidence from 1988-2008, *The Business Lawyer* 65, no. 1 (May 2010). Selected by academics as one of the "top ten" articles in corporate/securities law for 2010, out of 447 articles published in that year.

Is Delaware's Antitakeover Statute Unconstitutional? Further Evidence and a Reply to Symposium Commentators, *Business Lawyer* 65, no. 1 (May 2010).

Auction? Negotiate? A Dealmaker's Guide, *Harvard Business Review* (Dec. 2009)

Go-Shops vs. No-Shops in Private Equity Deals: Evidence and Implications, *The Business Lawyer* 63, no. 1 (2008). Selected by academics as one of the "top ten" articles in corporate/securities law for 2008, out of 480 articles published in that year.

The Emerging Problem of Embedded Defenses: Lessons from Air Line Pilots Ass'n Intl. v. UAL Corp., *Harvard Law Review* 120, no. 5 (March 2007).

Post-Siliconix Freeze-Outs: Theory & Evidence, *Journal of Legal Studies* 36 (Jan. 2007). Selected by academics as one of the "top ten" articles in corporate/securities law for 2007, out of 484 articles published in that year.

Oracle vs. PeopleSoft: A Case Study, *Harvard Negotiation Law Review* 12 (Winter 2007) (with D. Millstone).

Bargaining in the Shadow of PeopleSoft's (Defective) Poison Pill, *Harvard Negotiation Law Review* 12 (Winter 2007).

Fixing Freezeouts, *Yale Law Journal* 115, no.1 (Oct. 2005). Selected by academics as one of the "top ten" articles in corporate/securities law for 2005, out of 410 articles published in that year.

Takeover Defenses and Bargaining Power, *Journal of Applied Corporate Finance* 17, no.4 (Fall 2005).

The Disappearing Delaware Effect, *Journal of Law, Economics & Organization* 20, no.1 (April 2004). Selected by academics as one of the "top ten" articles in corporate/securities law for 2004, out of 439 articles published in that year.

Bargaining in the Shadow of Takeover Defenses, *Yale Law Journal* 113, no.3 (Dec. 2003). Selected by academics as one of the "top ten" articles in corporate/securities law for 2004, out of 439 articles published in that year.

The Drivers of Market Efficiency in Revlon Transactions, *Journal of Corporation Law* 28, no.4 (Summer 2003).

The Trouble With Staggered Boards: A Reply to Georgeson's John Wilcox, *Corporate Governance Advisor* 10, no.6 (Nov./Dec. 2002) (with L. Bebchuk & J. Coates).

The Influence of Antitakeover Statutes on Incorporation Choice: Evidence on the "Race" Debate and Antitakeover Overreaching, *University of Pennsylvania Law Review* 150, no.6 (June 2002).

The Powerful Antitakeover Force of Staggered Boards: Further Findings and a Reply to Symposium Commentators, *Stanford Law Review* 55, no.3 (Dec. 2002) (with L. Bebchuk & J. Coates). Selected by academics as one of the "top ten" articles in corporate/securities law for 2003, out of 450 articles published in that year.

The Powerful Antitakeover Force of Staggered Boards: Theory, Evidence & Policy, *Stanford Law Review* 54, no.9 (June 2002) (with L. Bebchuk & J. Coates). Selected by academics as one of the "top ten" articles in corporate/securities law for 2002, out of 350 articles published in that year.

A Buy-Side Model of M&A Lockups: Theory and Evidence, *Stanford Law Review* 53, no.2 (Nov. 2000) (with J. Coates). Selected by academics as one of the "top ten" articles in corporate/securities law for 2001, out of 300 articles published in that year.

A New Takeover Defense Mechanism: Using an Equal Treatment Agreement as an Alternative to the Poison Pill, *Delaware Journal of Corporate Law* 23, no.2 (1998).

Note, Using Capital Cash Flows to Value Dissenters' Shares in Appraisal Proceedings, *Harvard Law Review* 111, no.7 (May 1998).

Other Activities

Chairman of the Board, LKQ Corp. (NASDAQ: LKQ)

Faculty Chair, Advisory Committee on Shareholder Responsibility, Harvard University

Member, New York State Bar Association

Expert Testimony (Past 5 Years)

Vintage Rodeo Parent, LLC et al. v. Rent-A-Center, Inc., C.A. No. 2018-0927-SG (Del. Ch. 2019) (report & deposition)

Wilmington Trust Co. v. Hellas Tellecommunications et al., Index No. 653357/2011 (NY 2019) (report & deposition)

Glencore Canada Corp. v. H.M.Q, Court File No. 2014-887(IT) G (Tax Court of Canada 2019) (report & trial testimony)

Parallax Energy LLC v. Cherniere Energy, Inc., NO. 14-17-00982-CV 08-13-2019 (Tx. 2019) (deposition)

In re Versum Materials Inc. Stockholder Litig., C.A. No. 2019-0206-JTL (Del. Ch. 2020) (reports).

Dillon Trust Co. LLC, et al. v. U.S., Nos. 17-1898T, 17-2022T, 17-2023T (reports, deposition & trial testimony) (U.S. Court of Federal Claims 2020)

Align Technology, Inc. v. SDC Financial, LLC et al. (Case No. 01-19-0002-0945) (Arbitration 2020) (deposition)

The Williams Companies Stockholder Litig., C.A. No.2020-0707-KSJM (Del. Ch. 2020) (reports, deposition & trial testimony)

Roofers' Pension Fund v. Joseph C. Papa, et al., Case No. 2:16-cv-02805-MCA-LDW (2021) (reports & deposition)

In re WeWork Litigation, C.A. No. 2020-0258-AGB (2021) (report & deposition)

Matthew Sciabacucchi et al. v. Charter Communications et al., C.A. No. 11418-VCG (Del. Ch. 2021) (reports & deposition)

Bergeron Environmental & Recycling, LLC vs. LGL Recycling, LLC et al., Case No. 16-000158 (07) (Fla. 2021) (report, deposition & trial testimony)

In re Straight Path Communications Inc. Consol. Stockholder Litig., C.A. No. 2017-0486-SG (Del. Ch. 2021) (report, deposition & trial testimony)

City of Missoula v. Carlyle Infrastructure Partners, L.P., et al, Case No. 01-19-0000-1366 (Arbitration 2021) (report & trial testimony)

William J. Brown v. Matterport, Inc., C.A. No. 2021-0595-LWW (Del. Ch. 2021) (reports, deposition & trial testimony)

Deutsche Bank National Trust Co. v. Morgan Stanley ABS Capital, Inc., Case No. 651959/2013 (N.Y. 2022) (report & deposition)

In re Cloudera Inc. Securities Litig., Lead Case No. 19CV348674 (Cal. 2022) (report & deposition)

In re Tesla, Inc. Securities Litig., Case No. 18-cv-04865-EMC (N.D. Cal. 2022) (reports, deposition & trial testimony)

In Re Willowbrook Ethylene Oxide Litigation, No. 2018-L-010475 (Ill. 2022) (report, deposition & trial testimony)

In re Columbia Pipeline Group, Inc., C.A. No. 2018-0484-JTL (Del. Ch. 2022) (report, deposition & trial testimony)

DCP NGL Services, LLC, v. Anadarko Petroleum Corp. et al., CPR File No. G-21-54-S (Arbitration 2022) (report & deposition)

Politan Capital Management LP v. Masimo Corp et. Al., C.A. No. 2022-0948-NAC (Del. Ch. 2023) (reports & deposition)

Texas Pacific Land Corp. v. Horizon Kinetics LLC, C.A. No. 2022-1066-JTL (Del. Ch. 2023) (report, deposition & trial testimony)

Mewawalla v. Stanley C. Middleman et al., C. A. No. 21-cv-09700-EMC (N. D. Cal. 2023) (report & deposition)

Fishel et al. v. Liberty Media Corp., Sirius XM Holdings, Inc. et al., C.A. No. 2021-0820-KSJM (Del. Ch. 2023) (report & deposition)

Terraform Power Parent, LLC et al. v. Orrick, Herrington & Sutcliffe LLP, Reference No. 1425037813 (Arbitration 2023) (reports & deposition)

Davis v. Cerberus Capital Management, LP, et al., Index No. 654027/2013 (NY 2023) (report & deposition)

Current thru December 19, 2023

Appendix B

Materials Considered

Materials Considered[1]

Legal

Complaint. *Arm Ltd. v. Qualcomm Inc., Qualcomm Technologies, Inc., and NuVia, Inc.* (D. Del. No. 1:22-cv-01146) (Aug. 31, 2022).

Defendants' Answer and Defenses to Plaintiff's Complaint and Jury Demand and Defendants' Counterclaim. *Arm Ltd. v. Qualcomm Inc., Qualcomm Technologies, Inc., and NuVia, Inc.* (D. Del. No. 22-01146) (Sept. 30, 2022).

In re Starz Appraisal, No. 12968-VCG, 2018 WL 4922095 (Del. Ch. Oct. 10, 2018).

In re Williams Cos. Stockholder Litigation, No. 2020-0707-KSJM, 2021 WL 754593 (Feb. 26, 2021).

SQL Solutions, Inc. v. Oracle Corp., 1991 WL 626458 (N.D. Cal. 1991).

Depositions

Abbey, Will. Deposition (Oct. 27, 2023).

Grisenthwaite, Richard. Deposition (Nov. 15, 2023).

Gulati, Manu. 30(b)(1) Deposition (Oct. 12, 2023).

Haas, Rene. Deposition (Dec. 12, 2023).

Herbert, Tim. Deposition (Oct. 25, 2023).

Segars, Simon. Deposition (Nov. 16, 2023).

Thompson, James. 30(b)(6) Deposition (Nov. 28, 2023).

Williams, Gerard III. Deposition (Nov. 3, 2023).

Williamson, Paul. Deposition (Nov. 9, 2023).

[1] In preparing my report, I considered the documents listed here along with any items cited or referenced in the body and footnotes of my report.

Relevant Produced Documents

Agreements

[redacted]

Annex 1 to the Architecture License Agreement Between Arm Limited and NuVia, Inc (Mar. 27, 2020) (ARM_00057230).

Annex 1 to the Architecture License Agreement Between Arm Limited and Qualcomm Global Trading Pte, Ltd. (May 29, 2013) (ARM_00063298).

Architecture License Agreement ("ALA") Between Arm Limited and Qualcomm Global Trading Pte, Ltd. (May 30, 2013) (ARM_00044650).

[redacted]

Master Royalty Schedule Between Qualcomm Global Trading Pte, Ltd. and Arm Limited (May 30, 2013) (LES-LTM-20780) (ARM_01298891).

Non-Disclosure Agreement Between Arm Limited and NuVia, Inc. (Mar. 19, 2019) (ARM_00058413).

[redacted]

Technology License Agreement ("ALA") Between Arm Limited and NuVia, Inc. (Sept. 27, 2019) (ARM_00059183).

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Emails

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[redacted]

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[redacted]

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 CONFIDENTIAL

[redacted]

[redacted]

Miscellaneous

[redacted]

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Exhibit 5

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

ARM LTD., a U.K. corporation,

Plaintiff,

v.

QUALCOMM INC., a Delaware corporation, QUALCOMM TECHNOLOGIES, INC., a Delaware corporation, and NUVIA, INC., a Delaware corporation,

Defendants.

C.A. No. 22-1146-MN

EXPERT REPORT OF RAVI DHAR REGARDING TRADEMARK INFRINGEMENT

CONTAINS HIGHLY CONFIDENTIAL – ATTORNEYS' EYES ONLY INFORMATION

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I. QUALIFICATIONS

1. My name is Ravi Dhar. I am the George Rogers Clark Professor of Management and Marketing at the Yale School of Management. I am also the Director of the Yale Center for Customer Insights at the School of Management at Yale University. I also have an affiliated appointment as a Professor of Psychology at the Department of Psychology, Yale University. In addition, I serve or have served on the editorial board of peer-reviewed consumer research journals such as the Journal of Consumer Psychology, Journal of Consumer Research, and Journal of Marketing and Marketing Letters. Previously, I was the Associate Editor of Journal of Marketing Research, the past Area Editor of Marketing Science, and the Associate Editor of Journal of Consumer Research. My academic work focuses on branding, consumer behavior, consumer psychology, marketing management, marketing strategy, survey design, methodology, and evaluation.

2. My teaching responsibilities at Yale University's School of Management include two doctoral courses that examine advanced research topics in marketing. I also teach or have taught several different courses for graduate students who are enrolled in the MBA program or the Executive MBA program at Yale: Consumer Behavior, E-Business and Marketing, Marketing Strategy, Marketing Management, Marketing of Financial Services, and Strategic Marketing Leadership: The Role of A CMO. I have also taught and given seminars to mid-level and senior-level executives in more than a dozen countries in North and South America, Asia, and Europe.

3. I hold a Ph.D. and Master of Science in Business Administration from the University of California at Berkeley. I have published more than 85 papers in journals, proceedings, and as book chapters, including leading marketing, psychology, and management journals, such as the Harvard Business Review, Journal of Behavioral Decision Making, Journal

of Business, Journal of Consumer Psychology, Journal of Consumer Research, Journal of Marketing Research, Journal of Personality and Social Psychology, Management Science, Marketing Science, Nature Climate Change, Organizational Behavior and Human Decision Processes, Sloan Management Review, and other peer-reviewed and industry journals.

4. Several of my publications were also considered for research awards such as the Paul E. Green Award ("The Effect of Forced Choice on Choice," Finalist in 2004) and the William O'Dell Award ("Consumer Choice Between Hedonic and Utilitarian Goods," Winner in 2005; "Making Complementary Choices in Consumption Episodes: Highlighting Versus Balancing," Finalist in 2004; "The Effect of Forced Choice on Choice," Finalist in 2008 and "Preference Fluency in Choice," Finalist in 2012). The William O'Dell Award is presented to the Journal of Marketing Research article that has made the most significant, long-term contribution to marketing theory, methodology, and/or practice. The Paul E. Green Award is presented to the Journal of Marketing Research article that shows or demonstrates the most potential to contribute significantly to the practice of marketing research. I have been awarded the 2012 Distinguished Scientific Accomplishment Award from the Society of Consumer Psychologists, which is given annually to honor a scholar who has made significant and lasting contributions in the field of consumer psychology. A study of 475 marketing faculty members at top 30 schools (as of spring 2017), ranked me as one of the four most productive marketing faculty members (among those with at least one publication per year in one of the four top marketing journals over the 10-year period between 2007 and 2016), tying for rank 2 through 4 with two other faculty.[1] A detailed listing of my educational background and publications is set forth in my curriculum vitae, which is attached to the end of this report as **Exhibit A**.

[1] Van Osselaer, Stijn M. J., and Sarah Lim, "Research Productivity of Faculty at 30 Leading Marketing Departments," Marketing Letters, (2019): 1-48, at pp. 1-3, 8 (Table 3).

5. My fields of expertise are branding, consumer and customer psychology, marketing management, marketing strategy and survey design, methodology, and evaluation. My current research focuses on various aspects of marketing and branding, including consumers' decision-making, the manner in which consumers acquire and process information when forming product perception and preferences, the effect of product attributes (including trademarks) and information presentation on consumer purchase and consumption decisions and the effect of different "marketing mix" activities (such as promotions and advertising) on consumer purchase decisions.

6. I have served as an expert witness for both claimants and defendants on marketing research issues in a variety of litigation matters. A list of recent cases in which I have testified as an expert witness at trial or by deposition in at least the past four years is attached as **Exhibit B**.

II. ASSIGNMENT

7. I have been engaged by Morrison and Foerster LLP, on behalf of Plaintiff Arm Ltd. ("Arm") to opine on certain issues related to U.S. Registration Nos. 5,692,669 ("'669 Trademark") and 5,692,670 ("'670 Trademark") (collectively, "Arm Trademarks" or "Arm Marks") and Arm's claims against Defendants Qualcomm Inc., Qualcomm Technologies, inc. (collectively "Qualcomm") and NuVia, Inc. ("Nuvia").

8. It is my understanding that Arm has filed this lawsuit against Defendants for breach of contract, trademark infringement, and false designation of origin.[2]

9. In this case, I was asked to opine, from a marketing and consumer behavior perspective, on the following issues:

a. The benefit of a strong mark or brand in the marketplace;

[2] Complaint. *Arm Ltd. v. Qualcomm Inc., Qualcomm Technologies, Inc., and NuVia, Inc.* (D. Del. No. 1:22-cv-01146) (Aug. 31, 2022) ("Complaint") ¶¶ 1-3.

b. Whether Arm's Trademarks and brand are distinctive and strong in the United States marketplace context;

c. Whether Qualcomm's unlicensed use of the Arm Trademarks in connection with "Nuvia Products," i.e., technology that encompasses Nuvia technology developed under now terminated Nuvia-Arm ALA[3]—[redacted][4]—would likely result in confusion (i.e., whether Qualcomm's use of the ARM Marks is likely to cause purchasers of these products to falsely believe that there is some common ownership, affiliation with, connection to, or association with the Arm Trademarks, as to the origin, sponsorship, or approval of the Plaintiff, including whether such products have been validated by Arm);

d. Whether Qualcomm's use of the Arm Trademarks is likely to cause harm by impacting the brand or result in loss of sales by Arm and Arm's licensees that serve the same market.

III. RELEVANT LEGAL STANDARDS

10. I have been informed of general legal principles relevant to my opinions in this matter. I have used these legal principles in forming my opinions.

11. I have been informed that, to prove infringement of a trademark, it must be shown that (1) Arm owns a valid, protectable trademark, and (2) Defendants' use of the mark is likely to cause confusion.

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[3] For purposes of this report, I will refer to these products as "Nuvia Products." I understand that Nuvia developed the Phoenix core, a custom central processing unit ("CPU") core based on the Arm architecture, under its ALA. Tyson, Mark. "Nuvia 'Clean-Sheet CPU Design' Performance Previewed." *Hexus* (Aug 11, 2020). <https://hexus.net/tech/news/cpu/144733-nuvia-clean-sheet-cpu-design-performance-previewed>; [redacted]

[4] Per Section [redacted] of the Nuvia ALA, ARM_00059183 – 199 at -196; *see* ¶ 62.

IV. MATERIALS CONSIDERED

12. In forming my opinions, I drew on my knowledge, education, and experience in marketing and branding developed over the past several decades. I reviewed case-specific materials provided to me by counsel, as well as other documents discussed in this report. The materials that I relied upon include those cited in this report and the materials disclosed in **Exhibit C** to this report.

V. SUMMARY OF OPINIONS

13. Based on my knowledge and experience, well-established principles of branding, my analysis of documents and testimony provided to me by counsel and cited herein, and my own independent research, my conclusions are as follows:

- Arm's brand and Trademarks are strong and confer value in the marketplace.
- Strong customer acceptance of Arm's technology and Arm licensed products signifies a high standard of quality and innovation associated with Arm's Trademark that Arm has built over decades.
- Arm's Trademarks also signify compliance with the Arm Instruction Set Architecture ("ISA") and, in the case of technology developed under an ALA license, verification, and validation in accordance with the applicable provisions in the relevant license Annex.

14. Qualcomm's prior history and usage of Arm's Trademarks, along with requirements in the relevant agreements and materials that it will provide to customers, demonstrate a high likelihood that Qualcomm will continue to use Arm's Trademarks in connection with its future products, particularly Nuvia Products.

15. I also understand from the materials I reviewed that Qualcomm has used Arm's Trademarks in connection with its future Nuvia Products at least as recently as the Qualcomm

Snapdragon Summit, press releases, its earning calls, and other public statements, all within the past year. Qualcomm's use of Arm's Trademarks is likely to cause customer confusion. Thus, Qualcomm's unauthorized use of the Arm Mark for Nuvia Products is likely to mislead customers and other relevant industry participants into believing that there is some connection as to source, affiliation, sponsorship, or approval between Arm and Qualcomm. By using the Arm Mark in connection with the Nuvia Products, Qualcomm would benefit from the positive and favorable associations with the Arm Mark.

16. This unauthorized use is also likely to cause harm to Arm. First, Qualcomm's use of Arm's Trademarks may result in loss of control to Arm of its brand and goodwill, by falsely associating the Nuvia Products with Arm's brand. Second, Qualcomm's sale of the Nuvia Products may divert customers away from Arm, who may select a Nuvia Product rather than an Arm product or an Arm licensed product, understanding mistakenly that they are interchangeable.

17. The opinions I express in this report are based on my background and experience, along with my review of materials provided to me by counsel, and of research that I carried out in relation to this engagement. If called to testify, I expect to offer the opinions expressed in this report and the basis for those opinions.

18. My analyses and opinions in this report are based on information available to me as of the date of this report. I reserve the right to modify or supplement my testimony and this report in response to any further information provided by the parties and/or in light of additional documents or testimony brought forth through the ongoing discovery in this case, at trial, or otherwise, which may be brought to my attention after the date of my signature below. I reserve the right to modify or supplement my opinions in view of arguments made by any person

retained by Qualcomm, including Qualcomm's counsel and anyone it engages to provide opinions.

19. I am being compensated at the rate of $950 per hour for my services. The compensation is in no way tied to the outcome of this matter or my opinion.

VI. BACKGROUND

A. ARM COMPANY BACKGROUND

20. Arm is a world leader in its industry, developing processor architectures, including instruction set architectures, and processor core designs implementing those architectures. "Arm's CPU technology has been an industry leader for many years and continues to be the most widely deployed architecture globally." Arm's CPU architecture "has resulted in the proliferation and evolution of computers as people know them today. [By enabling] the mobile phone and smartphone revolution, and through [its] focus on energy efficiency and [its] history of continuous innovation, [Arm has] enabled new categories of 'smart' consumer electronics."[5]

21. "Software developers write software for Arm-based devices because it offers the biggest market for their products, and chip designers choose Arm processors because they have the broadest support of software applications."[6]

22. "In the fiscal year ended March 31, 2023, more than 260 companies reported that they had shipped Arm-based chips, and…approximately 70% of the world's population uses Arm-based products."[7]

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[5] ARM_01259705 – 0105 at -9720, -9792.
[6] Arm SEC Form 424B4 (September 13, 2023) <https://www.sec.gov/Archives/edgar/data/1973239/000119312523235320/d550931d424b4.htm> at 2.
[7] ARM_01259705 – 0105 at -9792.

23. I understand from the materials I considered that processor cores are the parts of a computer's Central Processing Unit, or "CPU," that read and execute program instructions to perform specific actions. Modern CPUs frequently integrate multiple processor cores on a single semiconductor chip or integrated circuit ("IC"), and they are often referred to as "system on chip" or "SoC" devices.[8]

24. CPUs are used in a variety of industries or market segments, including personal computing, mobile, cloud computing, automotive, artificial intelligence, Internet of Things ("IoT"), servers, data centers, and in effectively every other industry that utilizes computing devices.[9]

25. Technology companies around the world use Arm processor technologies in products ranging from smartphones to servers.[10]

26. Since Arm was founded in 1990, it has made significant investments to develop and market its products.[11] In the mid-1990s Arm CPUs gained significant traction in the mobile market because of the processors' power efficiency and performance.[12] Arm's more recent investments have focused on making it a "ubiquitous provider of compute technology in all market segments."[13] Arm is also focused on expanding into new markets via developing

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[8] "Licensing Arm Technology: Access for Everyone." *Arm*. <https://www.arm.com/products/licensing>; "The ARM Processor Business Model." *Arm*. <https://developer.arm.com/documentation/dht0001/a/architectures--processors--and-devices/the-arm-processor-business-model>.

[9] *See, e.g.*, "Partner Ecosystem Catalog." *Arm* <https://www.arm.com/partners/catalog/results#sort=date%20descending&numberOfResults=12>; "CPU Architecture." *Arm.* <https://www.arm.com/architecture/cpu>.

[10] "Partner Ecosystem Catalog." *Arm* <https://www.arm.com/partners>; Deposition of Paul Williamson, November 9, 2023, p. 279; ARM_01259705 – 105 at -9713.

[11] ARM_01259705 – 0105 at 9714.

[12] *Id.*

[13] *Id.*

multiple product families optimized for specific markets such as smartphones, cloud computing, networking, automotive, and IoT.[14]

27. I understand from the materials I considered that Arm's processors and business models offer unique customer benefits. "Arm's flexible and modular design IP enables customers to build chips optimized for the PPA requirements for a specific use case or end market… By developing a wide range of CPU and related technologies, Arm can provide a CPU optimized for various use cases to reduce both energy consumption and area (with area being a key driver of the ultimate cost of a chip)."[15]

28. Arm's position in the industry allows it to provide unique value to its customers: "To further reduce our customers' costs and to help de-risk their product development efforts, we combine our CPU products and SoC knowledge with our deep understanding of our ecosystem partners' design tools and manufacturing processes to provide processor products that not only optimize for power and performance, but also accelerate time to market for our customers."[16]

B. ARM TRADEMARK BACKGROUND

29. Arm owns intellectual property relating to its processor architectures and designs, including, among other things, trademarks.[17]

30. Arm owns U.S. Registration Nos. 5,692,669 and 5,692,670 for the ARM word mark in standard characters and the stylized ARM mark featuring the word "arm" in all lower-case letters (collectively, the "Arm Trademarks" or "ARM Marks"), as pictured below:

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[14] *Id.*
[15] Arm SEC Form 424B4 (September 13, 2023) <https://www.sec.gov/Archives/edgar/data/1973239/000119312523235320/d550931d424b4.htm> at 6.
[16] Arm SEC Form 424B4 (September 13, 2023) <https://www.sec.gov/Archives/edgar/data/1973239/000119312523235320/d550931d424b4.htm> at 6.
[17] "Terms and Policies – Trademarks." *Arm.* <https://www.arm.com/company/policies/trademarks>; Deposition of Will Abbey, October 27, 2023, p. 324.

Arm [18], and arm [19]

31. These marks are registered for "'[e]lectronic data processing equipment,' 'integrated circuits,' 'semiconductors,' 'microprocessors,' 'RISC-based instruction set architectures, namely, software instructions designed to function with particular microprocessors,' 'data processors,' 'printed circuit boards,' 'electronic circuit boards,' and related '[r]esearch, development and design,'" among numerous other goods and services. The applications to register ARM Marks were filed on July 31, 2017 and were issued on March 5, 2019. The application for Registration No. 5,692,669 has a claimed first use and first use-in-commerce date of November 30, 1990, while the application for Registration No. 5,692,670 has a claimed first use and first use-in-commerce date of August 1, 2017.[20]

C. <u>ARM ARCHITECTURE LICENSING SCHEME</u>

1. Arm's Licensing Ecosystem

32. Arm does not manufacture chips itself but instead licenses its processor technology to companies making chips and other electronic devices.[21] Arm licenses its processor technologies under Arm licenses such as architecture license agreements ("ALAs") and technology license agreements ("TLAs").[22]

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[18] U.S. Registration No. 5,692,669.
[19] U.S. Registration No. 5,692,670.
[20] Complaint, ¶ 71.
[21] "The ARM Processor Business Model." *Arm*. <https://developer.arm.com/documentation/dht0001/a/architectures--processors--and-devices/the-arm-processor-business-model>.
[22] Complaint ¶ 17. *See also* ARM_01259705 – 105 at -9794; Deposition of Simon Segars, November 16, 2023, pp. 29 – 30; Nuvia TLA, ARM_00059183 – 199.

33. Arm's TLAs allow for licensees to use specific "off-the-shelf" Arm processor core designs with only minor modifications.[23]

34. Arm provides support for licensees in developing Arm-compliant products under their TLA license.[24] In return, licensees provide royalty payments for Arm, and the royalty fees depend on the technology developed under the TLA.[25]

35. Arm's ALA licenses provide a licensee with greater rights and more flexibility. ALAs allow the licensee to design custom processor cores based on Arm's architectures, using Arm Technology and Arm Confidential Information.[26]

36. Section [redacted] of the Qualcomm ALA defines [redacted] to mean [redacted]

37. Similarly, Section [redacted] of the Nuvia ALA defines [redacted] as [redacted]

38. The Nuvia ALA included a [redacted] provision, which defined [redacted] as shown below:

[23] *See, e.g.*, Qualcomm TLA (ARM_0006458 – 512) at [redacted]
[24] *See, e.g.*, Qualcomm TLA (ARM_0006458 – 512) at [redacted]
[25] *See, e.g.*, Qualcomm TLA (ARM_0006458 – 512) at [redacted] *see also* Deposition of Will Abbey, October 27, 2023, 168:1-10.
[26] Deposition of Simon Segars, November 16, 2023, 30:12-32:12; Deposition of Will Abbey, October 27, 2023, 76:11-77:20.

[redacted]

39. [redacted][28]

40. The support and maintenance that Arm provides to its customers offers value that affords customers the ability to develop and innovate with Arm's support: "Our solution allows customers to build optimized chips, while reducing their design execution risk and their internal development costs…We invest significant time, resources and effort in the design and verification of each processor and work closely with our partners to ensure a standard of excellence in the processor products we deliver to our customers."[29]

41. Each TLA or ALA license agreement is negotiated separately with individual customers based on the licensee's intended use of [redacted] and [redacted][30]

42. Thus, Arm's business operates on an extensive licensing ecosystem. Arm engineers design processor core architecture, which Arm licenses to downstream customers who

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[27] Nuvia ALA, ARM_00059183.
[28] *See, e.g.*, Nuvia ALA, ARM_00059183 – 199, at [redacted]
[29] Arm SEC Form 424B4 (September 13, 2023) <https://www.sec.gov/Archives/edgar/data/1973239/000119312523235320/d550931d424b4.htm> at 6.
[30] *See* Shimpi, Anand Lal. "The ARM Diaries, Part 1: How ARM's Business Model Works." *AnandTech* (June 28, 2013). <https://www.anandtech.com/show/7112/the-arm-diaries-part-1-how-arms-business-model-works>.

use that technology for semiconductors. Arm's licensing ecosystem is well-established, widespread, and is based on the use of underlying [redacted], and derivatives or embodiments thereof.[31]

43. Arm has a significant licensing ecosystem, "with more than 30 billion Arm-based chips reported as shipped in the fiscal year ending March 31, 2023 alone, representing an approximately 70% increase since the fiscal year ended March 31, 2016."[32]

44. Arm reports that "based on royalty revenue information provided to us by customers in quarterly royalty reports, approximately 46% of [Arm's] royalty revenue for the fiscal year ended March 31, 2023 came from products released between 1990 to 2012."[33]

45. "For the calendar year ended December 31, 2022," Arm estimates that its total addressable market "was approximately $202.5 billion" and predicted "[it] will grow at a 6.8% compound annual growth rate ('CAGR') to approximately $246.6 billion by the end of the calendar year ending December 31, 2025."[34]

46. The continued existence and success of this licensing system depends on Arm's trust in and relationships with its partners. As Paul Williamson (Senior Vice President and General Manager of Client Line of Business at Arm) testified:

[redacted]

[31] ARM_01236577 – 579.
[32] ARM_01259705 – 0105 at -9792.
[33] ARM_01259705 – 0105 at -9794.
[34] Arm SEC Form 424B4 (September 13, 2023) <https://www.sec.gov/Archives/edgar/data/1973239/000119312523235320/d550931d424b4.htm> at 7.

[redacted]

47. In addition, the continued existence and success of Arm's licensing system depends on the substantial investment Arm makes in its research and development, technological innovation, and support it provides to its customers under its license agreements. As Arm explained in its second amended F-1 filing:

> "We will have to make significant expenditures to continue developing our semiconductor products and other products. The long development time of generally five or more years from the initial design of our semiconductor products until its incorporation into new end-user applications can place significant strain on our financial resources and personnel…To remain competitive, we must continue to develop new products, applications, and enhancements to our existing products and services, particularly as next generation technology is adopted by market participants. Allocating and maintaining adequate research and development resources, such as the appropriate personnel and development technology, to meet the evolving demands of the market is essential to our continued success."[36]

2. Licensing Rights to Arm Trademarks

48. An Arm TLA or ALA provides a license to use Arm's Trademarks in connection with a licensee's Arm-compliant products that a licensee developed under a specific TLA or

[35] Deposition of Paul Williamson, November 9, 2023, pp. 244 – 245
[36] ARM_01259705 – 0105 at -9739, -9745

ALA. A licensee's right to use Arm's Trademarks is [redacted]

49. Section [redacted] of the Nuvia ALA states: [redacted]

50. Section [redacted] of Qualcomm's ALA [redacted]

51. I understand from the materials I considered that Arm provides guidelines governing how a licensee may use the Arm Trademarks in connection with licensed products. Arm publishes Arm Branding Guidelines that all its licensees must follow. I also understand that the Branding Guidelines set forth instances under the ALAs and TLAs where a licensee is required to display an Arm Trademark, and other instances where the licensee is permitted, but not required, to display an Arm Trademark.[40]

52. Arm's Trademark Guidelines instruct that an Arm licensee with an ALA with Arm "shall apply the Arm corporate logo" in a few instances: (1) Die encapsulation: "to the die encapsulation (die package) of each unit of any Architecture Compliant Product," (2) Technical documentation: "in a prominent place, to any technical documentation for, or relating to, any Architecture Compliant Product distributed under license from Arm," and (3) Websites: "logo and/or the Arm word trademark and any appropriate Arm product/service/technology word

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[37] [redacted]
[38] ARM_00059183 – 199 at -9187.
[39] ARM_00044650 – 692 at -4656.
[40] *See* "Arm Branding Guidelines. *Arm*. < https://www.arm.com/company/policies/trademarks/guidelines-brand>.

trademark to the page(s) of your website relating to any Architecture Compliant Product distributed under license from Arm." An ALA partner is also permitted to apply the Arm corporate logo to product packaging, advertising and promotional materials, and hyperlinks.[41]

53. The term [redacted] is defined in the licensee's ALA. For example, in Qualcomm's ALA, Section [redacted], it defines [redacted]

54. Arm outlines the terms and policies associated with using the Arm Trademark. A licensee may only use specific versions of the term "Arm" in the context of common phrases, like "Arm technology," or "Arm-based."[43]

55. Companies will negotiate the use of these terms with Arm. For example, as Jonathan Armstrong, Head of Brand and Creative Services at Arm, testified, [redacted]

Mr. Armstrong further testified that [redacted]

56. Mr. Armstrong answered [redacted]

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[41] "Arm Branding Guidelines. *Arm*. < https://www.arm.com/company/policies/trademarks/guidelines-brand>.
[42] Qualcomm ALA (ARM_00044650) [redacted]
[43] "Arm Branding Guidelines. *Arm*. < https://www.arm.com/company/policies/trademarks/guidelines-brand>.
[44] [redacted]

[redacted]

57. [redacted]

D. QUALCOMM

1. Company Background

58. Qualcomm is a wireless technology company that develops various products, including semiconductors, designed to "deliver intelligent computing and advanced connectivity in mobile devices and other products."[49]

59. [redacted]

2. Qualcomm's Architecture License Agreement

60. [redacted]

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[46] [redacted]

[47] Nuvia ALA (ARM_00059183) [redacted] Qualcomm ALA (ARM_00044650) [redacted]

[48] [redacted]

[49] Qualcomm Form 10-K for FYE 2023, at 6.

[50] *See* ARM_00044650.

[51] *See* ARM_00060458.

[52] ARM_00044650.

61. Section [redacted] of this agreement provides [redacted]

62. I understand that Arm's position is that the [redacted] core and related SoCs are not licensed under Qualcomm's ALA because such technology was not developed under that ALA, and, because the Nuvia ALA was terminated, these products are no longer licensed under the Nuvia ALA.[54] For purposes of this report, I assume that Arm is correct and that the [redacted] core and related cores and SoCs are not licensed.

E. <u>NUVIA</u>

1. Company Background

63. Nuvia was founded as a start-up in 2019 by engineers who left Apple and Google and planned to design energy-efficient CPUs for data center servers based on a custom processor implementing the Arm architecture.[55]

64. In August 2020, Nuvia announced that their first-generation CPU code-named "Phoenix" would be "a custom core based on the ARM architecture."[56] Nuvia also announced that benchmark tests showed Phoenix could outperform rival products from Apple, Intel, AMD, and Qualcomm.[57]

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[53] ARM_00044650 at -656.
[54] Answer and Affirmative Defenses to Defendant's Amended Counterclaim, dated November 15, 2022.
[55] Complaint ¶ 20.
[56] Complaint ¶ 24; John Bruno & Sriram Dixit, "Performance Delivered a New Way, Silicon Reimagined" *Medium.* (Aug. 11, 2020) <https://medium.com/silicon-reimagined/performance-delivered-a-new-way-8f0f5ed283d5>
[57] *Id.*

2. Nuvia's Architecture License Agreement

65. [redacted][redacted]

66. Nuvia's ALA also [redacted][redacted]

67. Section [redacted] of the Nuvia ALA [redacted][redacted] [redacted][redacted]

68. Section [redacted] of the Nuvia ALA states that upon termination by Arm, [redacted][redacted] Section [redacted] also states: [redacted][3] Thus,

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[58] Complaint ¶ 21; ARM_00002956 – 71; ARM_00002988 – 3002.
[59] ARM_00002956 – 71 at -2959.
[60] ARM_00002956 – 71 at -2969.
[61] Complaint ¶ 28.
[62] ARM_00002956 – 71 at -2968.
[63] *Id.*

[redacted].

69. From September 2019 through early 2021, Nuvia worked to develop a customer processor core based on Arm architecture.[64] Arm provided documents, support, etc. to Nuvia to assist Nuvia's efforts to deliver an Arm-based core for the server market.[65]

F. QUALCOMM'S PLANS FOR NUVIA TECHNOLOGY

70. Although Qualcomm has its own ALA license with Arm, I understand that prior to acquiring Nuvia, Qualcomm had not recently developed any commercial product based on its own custom core.[66]

71. In early 2021, Qualcomm acquired Nuvia for $1.4 billion.[67] Qualcomm announced that it intended to integrate Nuvia's [redacted] CPU "across a wide portfolio of products" including Qualcomm Snapdragon platforms, which Qualcomm expected to "sample in the second half of 2022."[68]

72. [redacted]

73. Qualcomm then continued to develop the [redacted] CPU as well as several SoC products incorporating the [redacted] CPU, including products code-named [redacted]

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[64] Complaint ¶ 23.
[65] *Id.*
[66] Complaint ¶ 26.
[67] "Qualcomm Completes Acquisition of NUVIA." *Qualcomm.* (March 15, 2021) <https://qualcomm.com/news/releases/2021/03/qualcomm-completes-acquisition-nuvia#:~:text=Qualcomm%20Incorporated%20(NASDAQ%3A%20QCOM),working%20capital%20and%20other%20adjustments> (ARM_00024809).
[68] *Id.*
[69] ARM_00032602 (1/27/2021 letter from Z. Asghar to P. Williamson).

[redacted] ("Nuvia Products").[70] I understand that [redacted] is the name used for the [redacted] core and related SoCs.[71]

74. Since the acquisition, Qualcomm has made numerous statements, both internally and publicly, regarding its plans to release Nuvia Products incorporating the Nuvia-based technology soon, as detailed below.

75. As early as November 2022, Qualcomm announced that its [redacted] would "be integrated across a wide portfolio of Snapdragon powered products starting with PCs and including smartphones, digital cockpits, Advanced Driver Assistance Systems, extended reality, and infrastructure networking solutions."[72]

76. At Qualcomm's recent 2023 Snapdragon Summit Qualcomm previewed its Snapdragon X Elite SoC, that is reported by AnandTech to be "[b]ased on brand-new Arm CPU core design from their Nuvia subsidiary dubbed [redacted]'"[73] While the Snapdragon X Elite SoC will initially be used in laptop computers, Qualcomm has already announced plans to incorporate the SoC into smartphones and other devices.[74]

77. In his deposition, Mike Roberts confirmed that [redacted]

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[70] Complaint ¶¶ 43-53; [redacted]

[71] *See* 11/17/2023 Arm's First Supplemental Responses to Qualcomm's Interrogatory Nos. 6, 20.

[72] "[redacted] CPU: a custom CPU at the center of next-generation premium experiences on Snapdragon platforms." *Qualcomm*. (November 16, 2022) <https://www.qualcomm.com/news/onq/2022/11/[redacted] custom-cpu-at-center-of-next-gen-premium-experiences-on-snapdragon-platforms>.

[73] Smith, Ryan. "Qualcomm Previews Snapdragon X Elite [redacted] Starts in Laptops." *AnandTech*. (October 24, 2023) <https://www.anandtech.com/show/21105/qualcomm-previews-snapdragon-x-elite-soc-[redacted] cpu-starts-in-laptops->.

[74] *Id*.

[75] [redacted]

VII. ARM BRANDING

78. I use the term Arm brand to refer to the ARM Marks as seen in the marketplace. It is my opinion that the Arm brand is and has long been distinctive and strong. In the following sections, I first discuss the concepts and benefits of a strong brand. I then discuss the components of brand identity and what makes a strong brand. Finally, I apply these principles to the Business to Business ("B2B") market in which Arm competes and discuss the strength and distinctiveness of the Arm brand in the B2B marketplace context.

A. THE CONCEPT AND BENEFITS OF A BRAND

79. A brand is more than a trademark (e.g., a name or a symbol or a design).[76] It includes several tangible brand elements (e.g., words, logos, colors, designs, imagery) and intangible brand elements (emotional, attitudinal, sensory) that, collectively, stand for a unique source and a promise of certain benefits to prospective customers. However, a trademark is an important element of a company's brand.

80. Strong brands are valued because they can impact consumer purchase behavior. Consumers in the marketplace rely on brands to make effective and efficient purchasing decisions. First, the brand name or other brand identity elements allows consumers to quickly identify the source of a product or service, or its sponsor. This confers systematic advantages to a strong brand in the marketplace.

81. Second, a brand name and other brand identity elements take on meaning to customers based on repeated experience with the brand as well as from its advertising/promotional efforts and profile in the media. For example, the Arm brand is not only

[76] *See generally, e.g.*, Kevin Lane Keller, Strategic Brand Management: Building, Measuring and Managing Brand Equity, (4th Ed., Pearson 2012); David A. Aaker, Managing Brand Equity: Capitalizing on the Value of a Brand Name, (Free Press 1991).

strong and recognized in the microprocessor industry, it has also likely taken on a specific meaning around intangible attributes, such as high performance, and also signals compliance with the Arm Instruction Set Architecture.[77] It is this positive meaning of the brand among Arm's target customer base that leads to increased customer preference and loyalty.

82. Third, brands also serve to reduce the risk associated with product purchase decisions. Customers may perceive different types of risks in buying a product, such as functional risk (e.g., the product does not perform to expectations), financial risk (e.g., the price) or social risk (e.g., the product is not appreciated by others). Thus, a well-known brand can help reduce the risk associated with the purchase or trial of a new variety that is linked to a familiar and trusted mark.

83. Co-branding or composite branding strategy involves combining two or more existing brand names to create a brand name for a new product. Ingredient branding refers to a type of co-branding or a process in which a company markets an established branded ingredient or component used in its own products. Companies will often enter partnerships so that they can leverage the power of the ingredient brand to their mutual benefit.[78] The overall marketing strategy seeks to signal the benefits built on the strong and favorable brand identity of the ingredient (e.g., Arm in this case).

84. In the next section, I describe the key elements of a strong brand measured by brand knowledge, including brand performance and brand imagery.

[77] Deposition of Jonathan Armstrong, December 8, 2023, 82:20 – 83:8; 112:4-9.
[78] Composite Branding Alliances: An Investigation of Extension and Feedback Effects, C. W. Park, Sung Youl Jun, and Allan Shocker, Journal of Marketing Research, 1996.

B. THE COMPONENTS OF A STRONG AND DISTINCTIVE BRAND IDENTITY

85. As stated above, the commercial strength of a brand lies in what customers in the marketplace have learned, felt, seen, and heard about the brand because of their direct or indirect experiences over time. Thus, a strong and distinctive brand is built so that the desired thoughts, feelings, images, and perceptions become linked to the brand.

86. Because brand knowledge is the key to creating a strong brand from the consumer viewpoint, it is important to understand how brand knowledge is stored in memory. There are many different models of memory, and a well-established model is the associative network model of memory. According to this model, memory consists of a network of nodes and connecting links, in which nodes represent stored information or concepts, and links represent the strength of association between such information or concepts.[79] The information can be verbal, visual, abstract, or contextual in nature.[80]

87. Consistent with the associative network memory model, brand knowledge is conceptualized as consisting of a brand node in memory with a variety of associations linked to it. In particular, brand knowledge or the strength of a brand can be characterized in terms of two components: brand awareness and brand image.

- **Brand awareness** is related to the strength of the brand node in memory, as reflected by consumers' ability to identify the brand under different conditions.
- **Brand image** is perceptions about a brand as reflected by the brand associations held in consumer memory.

[79] *See* Kevin Lane Keller, Strategic Brand Management: Building, Measuring and Managing Brand Equity, (4th Ed., Pearson 2012).
[80] *See, e.g.*, Kevin Lane Keller, Conceptualizing, Measuring and Managing Customer-Based Brand Equity, J. Marketing 57(1):1-22 (1993).

- A strong brand tends to have both (a) strong awareness of identification of the mark with particular goods or services, and (b) strong brand image in memory in terms of the strength, favorability, and uniqueness of the brand associations.[81] Length of use, advertising/promotional efforts, exposure to the brand including its mentions as an ingredient of the product by the licensee and media are important factors in establishing brand awareness and a brand image and, thus, brand knowledge.
- Brand associations refer to the other informational nodes linked to the brand node in memory and contain the meaning of the brand for consumers. As discussed, next, these associations can be in all forms and refer to the characteristics of the product or aspects independent of the product.

88. The brand associations can be related to the **performance** of the brand. For example, performance-related associations can be about the quality or reliability provided by the Arm brand. The Arm Marks signal to consumers and to the public that the product is licensed and has been verified and validated by Arm as compliant with Arm's architecture.

89. The brand associations can also be about the **imagery** of the brand, or the way in which the brand is linked to its customers' psychological or emotional needs.

90. Like brand performance associations, imagery associations can be formed directly from a customer's own experience and contact with the brand or indirectly as communicated in brand advertising/promotional materials, directly as well as by ingredient branding.

91. Based on the brand imagery (how people think about the brand), brands also take on personality traits (how people feel about the brand). An important objective of building a

[81] *See* Kevin Lane Keller, Strategic Brand Management: Building, Measuring and Managing Brand Equity, (4th Ed., Pearson 2013).

strong brand is to create a personality for the brand that is attractive to the target and product market.

92. The key to building a strong brand identity comes from the specific associations related to either performance or to imagery that become linked to the brand identity. A brand's associations and meaning that are strong, favorable, and unique provide the underpinning of building strong brand equity that provides benefit to the brand owner.

VIII. ARM HAS BUILT A STRONG BUSINESS-TO-BUSINESS ("B2B") BRAND

A. <u>B2B COMPANIES</u>

93. Whether a company sells products or services to consumers, Business to Consumers ("B2C") or to other businesses, B2B, a strong brand is among its most important and sustainable assets.[82] Brands can facilitate the identification of products and business, differentiate them from their competition, communicate the value and benefits of a product or service, and reduce the risk and complexity involved in the buying decision.[83] These functions are common to both B2C and B2B brands, although the relative importance of each function varies between the two, with risk reduction cited as the most important function of B2B brands and signaling value as the most important for B2C.[84]

94. Numerous studies have established the importance of branding in B2B markets.[85] The benefits of a brand are built on the associations the brand has in the perceptions of the

[82] Balmer, J. M. T., et al., (2020), "The role of corporate brand image for B2B relationships of logistics service providers in China," Journal of Business Research, 117C, 850–861; Keller, K. L. (2013), Strategic Brand Management, Fourth/Global Edition, Essex: Pearson ("Keller (2013)"), p. 34; Iyer, P., et al. (2019), "Market orientation, positioning strategy and brand performance," Industrial Marketing Management, 81, 16–29; Leek, S. and G. Christodoulides (2012), "A Framework of Brand Value in B2B Markets: The Contributing Role of Functional and Emotional Components," Industrial Marketing Management, 41, 106–114.

[83] Kotler, P., and W. Pfoertsch (2006), B2B Brand Management, Evanston, IL: Springer ("Kotler and Pfoertsch (2006)"), p. 3.

[84] Kotler and Pfoertsch (2006), pp. 17–18, 46.

[85] Balmer, J. M. T., et al. (2020), "The role of corporate brand image for B2B relationships of logistics service providers in China," Journal of Business Research, 117, 850–861; Iyer, P., et al. (2019), "Market orientation, positioning strategy and brand performance," Industrial Marketing Management, 81, 16–29.

customers.[86] For both B2C and B2B brands, these associations can be both functional (e.g., quality, technology, capacity, infrastructure, after sales service, capabilities, reliability, and innovation) and emotional (e.g., risk reduction, reassurance, and trust).[87] Marketing research has found that both kinds of associations are important for B2B firms,[88] with functional associations generally contributing more to B2B brand strength.[89]

95. Although the foundational principles of creating a strong brand are similar for B2B and B2C brands, the targets and marketing strategies are different. For example, the buying process can differ significantly between business and consumer markets. B2B firms tend to have fewer customers, but often each customer is larger and the relationship with the customer is more long-term.[90] The products sold by B2B firms are often more complex, and buying transactions often involve significant technical expertise on both sides.[91] B2B products are generally purchased by a group within an organization rather than a single individual, and as such can be subject to complex within-firm restrictions and negotiations.[92] Finally, B2B firms face a "derived demand" in that the demand for B2B products as inputs depends on the final demand for its products.[93]

96. These differences mean that the marketing strategies through which a strong B2B brand is achieved can differ from those used by B2C brands. First, B2B brand focus tends to be

[86] Keller (2013), p. 31.
[87] Leek, S. and G. Christodoulides (2012), "A Framework of Brand Value in B2B Markets: The Contributing Role of Functional and Emotional Components," Industrial Marketing Management, 41, 106–114.
[88] Casidy, R., et al. (2018), "The relative influence of functional versus imagery beliefs on brand sensitivity in B2B professional services," Industrial Marketing Management, 72, 26–36; Leek, S. and G. Christodoulides (2012), "A Framework of Brand Value in B2B Markets: The Contributing Role of Functional and Emotional Components," Industrial Marketing Management, 41, 106–114.
[89] Kotler and Pfoertsch (2006), pp. 45–46; Casidy, R., et al. (2018), "The relative influence of functional versus imagery beliefs on brand sensitivity in B2B professional services," Industrial Marketing Management, 72, 26–36.
[90] Kotler and Pfoertsch (2006), p. 21.
[91] Kotler and Pfoertsch (2006), p. 21.
[92] Kotler and Pfoertsch (2006), p. 24.
[93] Kotler and Pfoertsch (2006), p. 22.

more targeted, since the relevant purchasers are a relatively small group of key buyers within customer firms, rather than the larger set of end users.[94] Second, although emotional appeals can also play a role in B2B branding, the degree of expertise among buyers and the often complex buying process at many firms means that many B2B brands emphasize the performance benefits and tangible points of differentiation of the product, and the reduction of risk associated with choosing the brand, relative to many B2C brands that emphasize the image of brand and its emotional connection with consumers.[95]

The next sections apply these principles of brand equity to the Arm brand.

B. ARM HAS A STRONG AND DISTINCTIVE B2B BRAND

97. Arm is a B2B brand because Arm's customers are other businesses. As I discuss in Section VI.A. above, Arm's primary offerings are CPU products that address diverse performance, power, and cost requirements.[96] Arm also offers complementary products such as graphic processing units ("GPUs"), development software and tools, and system IP.[97] Arm's offerings in turn enable its licensees to develop, manufacture, and sell a wide range of technology products—including smartphones, tablets and personal computers, data centers and networking equipment, vehicles, smartwatches, thermostats, and drones and industrial robotics—to their own customers.[9899] Thus, Arm competes in a business market rather than a consumer

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[94] Kotler and Pfoertsch (2006), p. 106. See also Casidy, R., et al. (2018), "The relative influence of functional versus imagery beliefs on brand sensitivity in B2B professional services," Industrial Marketing Management, 72, 26–36 at p. 111, in which the authors note that relationships with buyers are often a critical component of brand equity.
[95] Kotler and Pfoertsch (2006), pp. 45–46.
[96] *See* ARM_01259705.
[97] *Id.*
[98] *Id.*
[99] *See, e.g.*, "Amlogic Answers the UHD Challenge with Landmark Implementation of ARM Mali-450 MP6 GPU." *BusinessWire*. (November 20, 2013) <https://www.businesswire.com/news/home/20131119006559/en/Amlogic-Answers-the-UHD-Challenge-with-Landmark-Implementation-of-ARM-Mali-450-MP6-GPU≥ ("ARM designs the technology that is at the heart of advanced digital products, from wireless, networking and consumer entertainment solutions to imaging, automotive, security and storage devices. . . . Combined with comprehensive design services,

market. Although the positive experience of its customer's customers is an important part of Arm's offering, Arm's direct customers are chip developers and manufacturers, such as Amazon, Google, Intel, NVIDIA, and Samsung, rather than end customers.[100]

98. The value that the Arm Trademarks communicate to its customers is based on the pervasiveness and differentiating features of its CPU and ISA offerings. Arm's CPU architecture, which combines compute performance with industry-leading power efficiency, has become the world's most widely used CPU architecture.[101] The Arm ISA, which defines the software instructions that can be executed by the CPU, has also become the world's most popular ISA.[102] Software developers are incentivized to write software for Arm-based devices because it offers the biggest market for their products and chip designers are incentivized to choose Arm CPUs because they have the broadest support of software applications.[103] The Arm architecture and Arm ISA are crucial for Arm's customers to access this flourishing ecosystem.[104]

99. The Arm Trademarks have been strong and distinctive marks for decades as demonstrated by the following:

a. The Arm Trademarks have consistently been recognized by the World Intellectual Property Organization for its global goodwill, reputation, fame, and distinctiveness.[105]

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training, support and maintenance, and the company's broad Partner community, they provide a total system solution that offers a fast, reliable path to market for leading electronics companies.")

[100] *See* ARM_01259705.

[101] *Id.*

[102] *Id.*

[103] *Id.*

[104] *Id.*

[105] *See* ARM_01315253; ARM_01315276; ARM_01315241; ARM_01315259; ARM_01315333; ARM_01315304; ARM_01315237; ARM_01315323; ARM_01315315; ARM_01315297; ARM_01315338; ARM_01315283; ARM_01315287; ARM_01315310; ARM_01315328; ARM_01315264.

b. More than 260 companies have reported shipping Arm-based chips this year. And Arm CPUs were used in more than 250 billion chips last year.[106]

c. Arm has received many awards and accolades such as Overall Winner of the International Trade Awards in 2010; the Queen's Award for Enterprise in 2011;[107] the Linley Group's Best processor IP in 2014, 2018, and 2019;[108] and TSMC OIP Partner of the Year for Processor IP for 2009-2014, 2019, 2020, and 2021.[109]

100. Beyond building its brand through its performance and partnership with reference customers, Arm has worked to develop its brand among the relevant pool of potential buyers in other ways. Arm executives and employees regularly participate in industry events, on demand webinars, and Arm Tech Talks.[110] Each year, Arm also invites its licensees to an event where Arm presents its technology roadmap.[111]

101. A consistent finding in the marketing literature is that strong branding is most effective when the underlying product or service is of high quality, particularly in B2B markets

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[106] *See* ARM_01259705.
[107] Shaw, Chris. "Queen's Awards 2011: Chip designs bring win for ARM." *NewElectronics.* (April 21, 2011) <https://www.newelectronics.co.uk/content/news/queen-s-awards-2011-chip-designs-bring-win-for-arm/>.
[108] "The Linley Group Announces Winners of Annual Analysts' Choice Awards." *The Linley Group*. (January 16, 2015) <https://www.globenewswire.com/en/news-release/2015/01/16/1020683/0/en/The-Linley-Group-Announces-Winners-of-Annual-Analysts-Choice-Awards.html>; "The Linley Group Announces Winners of Annual Analysts' Choice Awards." *The Linley Group*. (January 12, 2018) <https://www.globenewswire.com/en/news-release/2018/01/12/1288835/0/en/The-Linley-Group-Announces-Winners-of-Annual-Analysts-Choice-Awards.html>; "Arm Mali-G77 GPU Named Best Processor IP in The Linley Group's Analysts' Choice Awards." *Arm.* (January 20, 2020). < https://newsroom.arm.com/news/arm-mali-g77-gpu-named-best-processor-ip-in-the-linley-groups-analysts-choice-awards>.
[109] "TSMC Honors ARM with Partner Award for Fifth Consecutive Year." *Arm*. (November 3, 2014). <https://www.arm.com/company/news/2014/11/29442>; "TSMC Announces 2020 OIP Partner of the Year Awards for Excellence in Accelerating Silicon Innovation." *TSMC*. (October 20, 2020) <https://pr.tsmc.com/english/news/2734>; "Arm Awarded TSMC Partner of the Year Award for Processor IP." *Arm.* (October 3, 2018). <https://newsroom.arm.com/news/arm-awarded-tsmc-partner-of-the-year-award-for-processor-ip>; "TSMC Recognizes Partners of the Year at 2021 OIP Ecosystem Forum." *TSMC.* (October 27, 2021) <https://pr.tsmc.com/english/news/2875>.
[110] *See* "Company Events." *Arm.* <https://www.arm.com/company/events>.
[111] Deposition of James Thompson, November 28,2023, 39:10-16.

where buyers often have a high degree of technical expertise in evaluating the products and services that they purchase. For Arm's CPU customers, the virtuous cycle of adoption created by the Arm ecosystem provides a rich software ecosystem and access to broad product markets.

102. Arm's second amended F-1 filing states that its "brand and reputation are critical factors in [its] relationship with customers, employees, governments, suppliers, and other stakeholders. [Its] failure to address, or the appearance of [its] failure to address, issues that give rise to reputational risk…could significantly harm [Arm's] brand and reputation."[112]

103. Arm offers benefits to downstream customers. "Arm CPUs run the vast majority of the world's software, including the operating systems and applications for smartphones, tablets and personal computers, data centers and networking equipment, and vehicles, as well as the embedded operating systems in devices such as smartwatches, thermostats, drones, and industrial robotics. [Arm] estimate[s] that approximately 70% of the world's population uses Arm-based products, and the scale of Arm's reach continues to expand, with more than 30 billion Arm-based chips reported as shipped in the fiscal year ended March 31, 2023, alone."[113]

104. Further, Arm's innovation is responsive to consumer demands. "As consumers and enterprises continue to demand more from their devices, the pervasiveness of high-performance and energy-efficient semiconductors will continue to expand."[114] In addition, as Arm's EVP and Chief Commercial Officer Will Abbey commented, "The growth of AI, I believe, is the growth of Arm…. We believe that whether it's training, which is taking place

[112] ARM_01259705 – 0105 at 9758.
[113] *See* ARM_01259705 – 0105 at -9712.
[114]*See* ARM_01259705 – 0105 at -9715.

today, which will lead to inferencing downstream, the ARM architecture is ideal to enable AI at scale."[115]

105. In summary, a brand is more than a unique identifier of source, it also communicates a promise of certain benefits to customers based on Arm technology. A strong brand like Arm arises from the thoughts, feelings, and associations that are linked to the Arm brand. The strength of the Arm brand means that products that are linked to Arm (e.g., as an ingredient of the product) are conferred positive associations that have been developed by the Arm brand over the years of successful innovation.

106. The ecosystem created by Arm over decades, enables Arm's customers to access broad markets by creating compatible CPUs and software architecture. The Arm brand and Arm Marks also signify versatility, balancing power-efficiency, and performance. Use of the Arm communicates these benefits. Accordingly, the Arm brand serves as a strong performance indicator when customers make purchasing decisions.[116]

C. <u>TRADEMARK INFRINGEMENT</u>

1. Qualcomm's Historical Use of Arm Trademarks

107. Qualcomm has consistently used Arm's Trademarks in customer communication for its products that incorporate, are derived from, use, or rely on [redacted]. For example, Qualcomm's Application Processors Selector Guide for IoT application processors include descriptions of several different tiers of Systems-on-Chip ("SoC"), noting that the CPU is made up of certain Arm cores or Arm "compliant" cores.[117]

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[115] Lardinois, Frederic. "Arm after the IPO." *TechCrunch*. (September 14, 2023) <https://techcrunch.com/2023/09/14/arm-after-the-ipo/>.
[116] ARM_01259705 – 0105 at 9758.
[117] "Qualcomm Application Processors Selector Guide." *Qualcomm.* <https://www.qualcomm.com/content/dam/qcomm-martech/dm-assets/documents/application-processors-selection-guide.pdf>.

108. As another example, the Device Specification for Qualcomm's Snapdragon™ 410E (APQ 8016E) processor, published in September 2016, includes several uses of Arm's Trademark.[118] The Specification described the features of the APQ 8016E chipset as including "Quad Arm Cortex" and included a functional block diagram showing the placement of the Arm processor cortex.[119] The APQ 8016E was marketed as suitable for use in "music players[,] cameras," gaming devices, and GPS and Wi-Fi technology.[120] The Product Brief for the APQ 8016E touts the use of Arm's Cortex and notes that the chipset features the Arm v8-A ISA, which is "an efficient instruction set."[121]

109. A Qualcomm's 2022 Tech Summit, it announced that its Kryo CPU will be "built on the latest ARM-V9 architecture."[122]

110. Qualcomm's Snapdragon 8 gen 3 Mobile Platform Product Brief, published October 23, 2023, described the CPU component as incorporating "Arm Cortex-X4 technology."[123]

111. Qualcomm has also used Arm's Trademarks in connection with press releases marketing its Snapdragon line of products. For example, a February 27, 2022, press release published in relation to the 2022 Mobile World Congress event, stated: "Qualcomm Technologies works with a broad range of OEMs, independent software vendors (ISVs), network

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[118] "Qualcomm® Snapdragon 410E (APQ 8016E) processor Device Specification." *Qualcomm.* (Sept. 2016) <https://www.qualcomm.com/content/dam/qcomm-martech/dm-assets/documents/snapdragon_410e_apq_8016e_data_sheet.pdf>.
[119] *Id.* at 9-12.
[120] *Id.* at 9.
[121] "Qualcomm® APQ8016E Application Processor." *Qualcomm.* <https://www.qualcomm.com/content/dam/qcomm-martech/dm-assets/documents/apq8016e-product-brief.pdf>.
[122] Sourabh Jain, "Qualcomm Snapdragon Tech Summit 2022- Snapdragon 8 Gen 2, [redacted] CPU, AR2 Gen 1 platform, and other announcements," *Business Insider.* (Nov. 17, 2022) <https://www.businessinsider.in/tech/news/qualcomm-snapdragon-tech-summit-2022-snapdragon-8-gen-2-[redacted] cpu-ar2-gen-1-platform-and-other-announcements/articleshow/95581109.cms>
[123] "Snapdragon® 8 Gen 3 Mobile Platform." *Qualcomm.* <https://docs.qualcomm.com/bundle/publicresource/87-71408-1_REV_B_Snapdragon_8_gen_3_Mobile_Platform_Product_Brief.pdf>.

operators, and channel partners to expand the Arm®-based Snapdragon computing ecosystem for enterprise use cases."[124]

2. Qualcomm's Current and Future Use of Arm Trademarks with Nuvia Products

112. Qualcomm has continued to describe the Nuvia-based Products using "Arm." For example, Qualcomm's public statements regarding the technology at issue use Arm's brand to communicate there is some connection as to source, affiliation, sponsorship, or approval between Arm and Qualcomm regarding the Nuvia Products.

a. A press release published on January 3, 2022 touts the "broad support from ecosystem partners for the PC industry's transition to Arm®-based computing," and at the same time states that Qualcomm's "acquisition of NUVIA uniquely positions Qualcomm Technologies to drive this industry wide transition." The press release quoted Qualcomm CEO Cristiano Amon saying: "The future of the PC industry is modern <u>Arm-based</u> architectures and Snapdragon compute platforms will continue to lead and define the future of productivity, education, and connected entertainment[.]"[125]

b. At Qualcomm's 2023 Snapdragon Summit, Director of Product Management Manju Varma announced that the [redacted] would be the first "CPU on Arm-based architecture to hit over 4GHz."[126]

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[124] "Qualcomm Expands Snapdragon Compute Ecosystem for the Next-Generation of Enterprise-Grade PCs." *Qualcomm.* (February 27, 2022) <https://www.qualcomm.com/news/releases/2022/02/qualcomm-expands-snapdragon-compute-ecosystem-next-generation-enterprise>.

[125] "Qualcomm and Leading Compute Partners Build Industry Momentum for Windows on Arm PCs Powered by Snapdragon Compute Platforms, Qualcomm Inc." *Qualcomm.* (Jan. 3, 2022) <https://www.qualcomm.com/news/releases/2022/01/>

[126] ARM_01422901 at 37:32.

c. On Qualcomm's November 1, 2023, Earnings Call, Qualcomm CEO Cristiano Amon explained the Snapdragon X Elite "Arm-based PC processor . . . is going to be part of the expansion of TAM [Total Addressable Market] for Qualcomm."[127]

113. [redacted][128]

114. [redacted]

115. At present, Qualcomm has continued to suggest sponsorship, affiliation, or certification of the Nuvia Products by Arm by publicly representing that it continues to use and develop derivatives or embodiments of [redacted], including the [redacted] Core.

116. For example, in June 2022, Qualcomm said that its Nuvia chips will soon join the industry-wide "ecosystem transition to Arm" and that by "late next year, beginning 2024, you're going to see Windows PCs powered by Snapdragon with a Nuvia-designed CPU."[130] In November 2022, Qualcomm said: "the creation of our custom CPU was started by Nuvia engineers while employed at Nuvia."[131]

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[127] "Qualcomm (QCOM) Q4 2023 Earnings Call Transcript." *The Motley Fool.* (September 30, 2023) <https://www.fool.com/earnings/call-transcripts/2023/11/01/qualcomm-qcom-q4-2023-earnings-call-transcript/>.
[redacted]
[130] Complaint ¶¶ 48-49 (citing *Qualcomm CEO on What He Really Thinks of Apple*, The Daily Charge (June 9, 2022), https://podcasts.apple.com/us/podcast/qualcomm-ceo-on-what-he-really-thinks-of-apple/id1091374076?i=1000565773375).
[131] "Qualcomm dubs Nuvia [redacted]" on track for 2023." *PCWorld.* (November 17, 2022) <https://www.pcworld.com/article/1382740/qualcomm-dubs-nuvia-cpu-[redacted]-track-for-2023.html>.

117. Terms such as "Arm-based" and "Arm-compliant" have a particular meaning within the relevant market, which conveys endorsement and sign-off by Arm of such products. In particular, [redacted].[132] [redacted], [redacted]

118. Qualcomm's use of Arm's Trademark in connection with the Nuvia Products—including with phrases such as "Arm-based" and "Arm-compliant," falsely convey that such products (i) have some connection as to source, affiliation, sponsorship, or approval between Arm and Qualcomm, (ii) are covered by an applicable license, and (iii) have been verified and validated by Arm.[134]

3. Third-Party Mention of Arm Trademarks Regarding Qualcomm's Nuvia Products

119. Even if Qualcomm no longer plans to use Arm's Trademarks in its communication, which is not the case at present, industry press covering the technology at issue has used Arm's brand to suggest endorsement, affiliation, or certification of the technology at issue by Arm.

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[132] [redacted]

[133] [redacted]

[134] *See* ¶ 62.

a. HONOR, a Chinese smartphone company announced at the 2023 Snapdragon Summit "the exciting news that HONOR is developing an ARM PC using the newly announced Snapdragon X Elite platform."[135]

b. An article published by Extremetech explains "[t]he Qualcomm and former Nuvia teams have morphed Nuvia's ARM designs into the [redacted] CPU core," and that the Snapdragon Z Elite chips, based on this CPU, "will replace the 8cx chips in the company's portfolio."[136]

c. An international business and financial news outlet article describes Qualcomm's "major announcement" regarding "the launch of its new [redacted]." The article notes "The [redacted] is Qualcomm's first custom Arm CPU design" and goes on to tout the performance and power metrics of the [redacted], stating the "[redacted] is a major development for the tech industry."[137]

d. In a video sponsored by Qualcomm, blogger Austin Evans notes that Qualcomm's Snapdragon X Elite chip is "Arm-Powered" and was "developed on Arm."[138]

e. An article published on October 29, 2023, by the Motley Fool, a private financial and investing advice company, stated "the new X Elite chips, powered by [redacted]

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135 Stradling, Colton. "HONOR announces its first ARM PC built on Snapdragon X Elite will release next year." *Windows Central.* (October 25, 2023) <https://www.windowscentral.com/hardware/honor-announces-its-first-arm-pc-built-on-snapdragon-x-elite-will-release-next-year>.

136 Whitwam, Ryan. "Qualcomm Announces Snapdragon X Elite Processor for Laptops." *ExtremeTech.* (October 25, 2023) <https://www.extremetech.com/computing/qualcomm-announces-snapdragon-x-elite-processor-for-laptops>.

137 Priya Pathak. "Qualcomm takes swing at Intel with [redacted], unlocks 240 fps gaming on flagship phones with 8 Gen 3: Top announcements from Snapdragon Summit." *Financial Express* (Oct. 25, 2023).

138 Evans, Austin. "The Biggest Upgrade for Windows PCs in YEARS." (October 28, 2023) <https://www.youtube.com/watch?v=Vt1EmsvEyd4>.

CPUs [Qualcomm] got when it acquired Arm-based designer Nuvia in 2021, claim some impressive performance."[139]

f. Counterpoint Technology Market Research published an article dated November 2, 2023 stating: "The Snapdragon X Elite is an ARM-based processor[.]"[140] The article notes several times that the [redacted] CPU is "Arm-based."[141]

120. That third parties, including industry news outlets and Qualcomm's own licensees, are using Arm's Trademark in connection with the Nuvia Products demonstrates that participants throughout the relevant industry are associating the Nuvia Products with Arm sponsorship and falsely assuming a licensing relationship exists between Arm and Qualcomm regarding the Nuvia Products.[142] Such third-party mentions also amplify the confusion created by Qualcomm's own use by suggesting Arm sponsorship and endorsement of the Nuvia Products to an even broader audience.

121. Qualcomm's unauthorized use of the Arm Mark for Nuvia Products will mislead its customers and other relevant industry participants into believing that there is some connection as to source, affiliation, sponsorship, or approval between Arm and Qualcomm. By using the Arm Mark in connection with the Nuvia Products, Qualcomm would benefit from the positive and favorable associations with the Arm Mark.

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[139] Rossolillo, Nicholas. "Qualcomm Is Gunning for a Piece of Intel's Lunch -- Time to Buy Qualcomm Stock?" *The Motley Fool.* (October 29, 2023) <https://www.fool.com/investing/2023/10/29/qualcomm-is-gunning-for-a-piece-of-intels-lunch-ti/>.

[140] "Qualcomm Snapdragon X Elite Unveiled: ARM-based SoC for Windows-powered AI PCs." *Counterpoint Research.* (November 2, 2023) <https://www.counterpointresearch.com/insights/qualcomm-snapdragon-x-elite-arm-based-soc-windows-ai-pc/>.

[141] *Id.*

[142] *See* ¶ 62.

D. QUALCOMM'S UNAUTHORIZED USE OF THE ARM MARK IS LIKELY TO HARM ARM

122. As discussed above, Qualcomm has used Arm's Trademarks in its communications about Nuvia Products that incorporate, are derived from, or rely on [redacted]. It has done so by marking the Nuvia Products with the ARM Mark, and by publicly describing the Nuvia Products as "Arm-based" and "Arm-compliant." As discussed, use of these terms and of the Arm Trademarks falsely signifies connection as to course, affiliation, sponsorship, or approval from Arm and verification and validation by Arm under an applicable ALA Annex and that the product is covered by a license to [redacted]. In other words, it signals that the Nuvia Products have gone through a verification and validation process with Arm's support and maintenance, such that they are technology that has been developed under a valid license with Arm and comply with Arm's ISA requirements.[143]

123. [redacted]

124. Further, Qualcomm's public statements regarding the technology at issue have already relied on Arm's brand to suggest endorsement, affiliation, or certification by Arm and confirm that Qualcomm intends to use Arm Trademarks in connection with products incorporating the [redacted] core. By describing the Nuvia Products with references to Arm, Arm-based, or Arm-compliant, and by using the ARM Mark in connection with promotion of the Nuvia Products, like at the Snapdragon Summit, Qualcomm has publicly made a clear connection between the technology at issue and Arm's brand.

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[143] Deposition of Jonathan Armstrong, December 8, 2023, 82:20-83:8.
[144] [redacted]

125. The absence of a license for Qualcomm's use of Arm's Trademarks in those products necessarily means that such use is infringing.[145]

126. By using the ARM Mark without Arm's permission in its press announcements, at its launch events, and on its website, Qualcomm has used an asset developed by Arm (its brand) to increase consumer acceptance of new products. The use of the familiar and trusted Arm brand will enable Qualcomm to communicate that the Nuvia Products are licensed and have been verified and validated by Arm, thereby facilitating acceptance and adoption of such products, and enabling Qualcomm to access the broad marketplace associated with the Arm ecosystem. Thus, by using the Arm Trademarks without Arm's permission, Qualcomm will draw on the equity of the Arm Mark to increase the likelihood of consumer acceptance of its products.

127. Qualcomm's unlicensed use of Arm's Trademarks will cause harm to Arm by resulting in a loss of control to Arm of its brand and goodwill. In general, the loss of brand image and goodwill occurs because any dissatisfaction or problems associated with the infringing user, or its products are likely to be erroneously attributed also to the trademark owner and/or its products. Negative attributions and inferences concerning the infringing user, or its products can also spillover to Arm if it is seen as being associated with such products.

128. As discussed above, the use of the Arm Trademarks and the terms "Arm-based" and "Arm-compliant" signal that the Nuvia Products have been developed under a valid Arm license. Qualcomm's unauthorized use of Arm's Trademarks means that how customers view the Arm Mark is now connected to the quality and outcomes associated with the Nuvia Products. For example, any Nuvia Products that have the unauthorized use of Arm's Trademarks and have some negative customer response or experience place Arm's valuable brand asset at risk.

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[145] *See* ¶¶ 61, 62, 66.

Customers may also mistakenly attribute any issues with the performance of Qualcomm's Nuvia Products also to presumed flaws in the Arm ISA or failures of Arm's own engineering team.

129. As Will Abbey (Arm's Executive Vice President & Chief Commercial Officer) testified during his deposition: [redacted]

130. Mr. Abbey also testified that [redacted]

131. Therefore, Qualcomm's and third parties' continued use of the Arm Trademarks and its continued drawing of a false connection between its Nuvia Products and Arm's brand in the eyes of the customer deprives Arm of control over its brand and the management of its goodwill in the industry and to consumers.

132. As discussed in Section VI.C., Arm licenses its technology to many different customers who compete in the same marketplace as Qualcomm. Qualcomm's unauthorized use of Arm's Trademark in connection with the Nuvia Products will likely divert sales from authorized users of Arm's Trademark (e.g., Arm's customers whose products are covered by a valid license with Arm). Customers who might have sought out an Arm product may instead turn to Qualcomm's products because they mistakenly understand, because of Qualcomm's infringing use of Arm Trademarks, that Qualcomm's Nuvia Products are equivalent to Arm technology, or somehow supported by Arm.

146 [redacted]

133. Customers of Nuvia Products themselves would be harmed by the deceptive nature of the sale and the loss of benefits they sought from using Arm's products. Customers seeking to use an Arm product who instead receive a Qualcomm product are harmed and deceived by getting a product that is not in fact sponsored by or affiliated with Arm, and does not come with the unique benefits, like the support and maintenance from Arm engineers, that a true partnership with Arm would bring.

E. QUALCOMM'S UNAUTHORIZED USE OF THE ARM MARK SHOULD NOT CONSTITUTE FAIR USE

134. I understand that Qualcomm contends that its unauthorized use of the Arm Trademarks "constitutes fair use."[148]

135. I have been informed that, to demonstrate fair use, Qualcomm must show (1) that its unauthorized use of the Arm Trademarks is necessary to describe both Arm's product or service and Qualcomm's product or service; (2) that Qualcomm uses only so much of the Arm Trademarks as is necessary to describe Arm's product; and (3) that Qualcomm's conduct or language reflect the true and accurate relationship between Arm's and Qualcomm's products or services.

136. It is my opinion that Qualcomm's unauthorized use of the Arm Trademarks would not constitute fair use. For example, as I discussed above in Section VII.C., Qualcomm's unauthorized use of the Arm Trademarks, in particular phrases such as "Arm-based" and "Arm compliant," falsely signifies that the Nuvia Products have been connection as to source, affiliation, sponsorship, or approval from Arm and have been verified and validated by Arm and that the Nuvia Products are covered by an applicable license to [redacted].[149]

[148] Defendants Responses and Objections to Plaintiff's First Set of Requests for Admission, Request No. 24.
[149] *See* ¶ 62.

Qualcomm's unauthorized use of the Arm Trademarks would ***not*** reflect the true and accurate relationship between Arm and Qualcomm's Nuvia-based Products, at least because there is no licensing relationship between Arm and Qualcomm with respect to the Nuvia Products and because the Nuvia-based Products have not gone through a verification and validation process with Arm's support and maintenance in order to comply with Arm's ISA requirements. (*See*, *supra*, Sec. VII.C.)

137. I have been informed that Qualcomm bears the burden to demonstrate fair use, including the factors discussed above in ¶ 135. Accordingly, I have not conducted a full analysis on why Qualcomm's unauthorized use of the Arm Trademarks would not constitute fair use, but I reserve the right to do so in response to any expert opinion offered by Qualcomm regarding fair use.

I declare, under penalty of perjury, that the foregoing is true and correct. Executed on December 20, 2023.

RAVI DHAR

EXHIBIT A

EXHIBIT A

June 2023

RAVI DHAR
Yale School of Management
165 Whitney Avenue
Yale University
New Haven, CT 06520
(203) 432-5947

Employment

George Rogers Clark Professor of Management	**2005 - Present**
Professor of Psychology (*joint appointment*)	**2003 – Present**
Director, Yale Center for Customer Insights	**2004 – Present**
Professor of Marketing,	**2000 – Present**
Associate Professor of Marketing,	1997 - 2000
Assistant Professor of Marketing	1992 - 1997
Yale School of Management	

Other Appointments

Visiting Faculty, HEC Paris	Summer 1996
Visiting Associate Professor, Stanford University	Spring 1998
Visiting Professor, Erasmus University	Summer 2000, 2001
Visiting Professor, New York University	Spring 2005, Spring 2010

Education

Haas School of Business, UC Berkeley	1988-1992
Ph. D. (Business Administration)	1992
M.S. (Business Administration)	1990
Indian Institute of Management	1987
M.B.A.	
Indian Institute of Technology	1985
B.Technology	

Academic Honors and Fellowships

Distinguished Alumnus Award, Indian Institute of Management, 2013
Distinguished Scientific Contribution Award, SCP, 2012
Yale SOM Alumni Association Teaching Award, 2012
Finalist O’Dell Award 2012
Finalist, O’Dell Award, 2008
Winner, O’Dell Award 2005
Finalist, O’Dell Award, 2004
Finalist, Paul Green Award, 2004
AMA Consortium Faculty Fellow, 2003- 2009, 2010, 2012, 2013
INFORMS Doctoral Consortium Faculty – Multiple Years
ACR Doctoral Consortium Faculty – Multiple Years
John A. Howard Doctoral Dissertation Award (Honorable Mention), 1993

EXHIBIT A

AMA Doctoral Consortium Fellow, 1991

Research Interests

Consumer Behavior	Marketing Strategy
Judgment and Decision Making	Branding
E-Commerce	Behavioral Finance

Teaching Interests

Marketing Management	Consumer Behavior
Marketing Strategy	Behavioral Decision Theory
Financial Services	E-Commerce Marketing

Professional Affiliation (Member)

American Marketing Association
Association for Consumer Research
Society of Judgment and Decision Making

Professional Activities

Editorial Board,
Journal of Consumer Research, 1997 – Present, *Past Associate Editor*
Journal of Consumer Psychology, 1997 – 2002, 2005 - Present
Journal of Marketing Research, 2001 – Present, *Associate Editor*
Journal of Marketing, 2005 - Present
Marketing Letters, 2000 - Present
Marketing Science, 2002- 2011, *Past Area Editor*

Occasional Reviewer, *Marketing, Management, Psychology Journals, NSF, etc.*

Publications in Journals

Approximate Number of Citations in Google Scholar: 22,000+

1. "Targeted Electronic Health Record Alerts to Improve Management of Patients Hospitalized with Heart Failure and Reduced Ejection Fraction: The PROMPT-AHF Clinical Trial," (w Lama Ghazi…Tariq Ahmad), *European Heart Journal*, 2023.
2. "Planning Prompts as a Tool for Increasing Habitual Sustainability Behaviors," (w. Eleanor Putnam-Farr, Jane Upritchard, Michiel Bakker, Maragret Gorlin), *Journal of the Association for Consumer Research*, 2023.
3. "Driving Sustainable Food Choices: How to Craft an Effective Sustainability Labeling System (w. Paul Stillman, Chavanne Handon, Jonathan Kaplan,

EXHIBIT A

Treeny Ahmed, Michiel Bakker), *Journal of the Association for Consumer Research*, 2023.

4. Electronic alerts to improve heart failure therapy in outpatient practice: a cluster randomized trial (w Lama Ghazi…Tariq Ahmad), Journal of the *American College of Cardiology*, 2022.

5. Alerting Clinicians to 1-Year Mortality Risk in Patients Hospitalized With Heart Failure: The REVEAL-HF Randomized Clinical Trial (w Tariq Ahmad et al.) JAMA Cardiology, 2022.

6. "The impact of touchscreen devices on consumers' choice confidence and purchase likelihood," (with Johannes Hattula and Walter Herzog), *Marketing Letters*, 2022.

7. "In the Face of Self-threat: Why Ambivalence Heightens People's Willingness to Act," (with Taly Reich and Alex Fulmer), *Organizational Behavior and Human Decision Processes*, 2022.

8. "Attractive and Confident: How Boosting Self-perceived Attractiveness Reduces the Context Effects of All-average, Default, and Compromise options," (with Zixi Jiang, Jing Xu, and Margaret Gorlin), *Journal of Marketing Research*, 2021.

9. The Curse of the Original: How and When Heritage Branding Reduces Consumer Evaluations of Enhanced Products (with Minju Han, George Newman, Rosanna Smith), *Journal of Consumer Research*, 2021.

10. When does Altruism Trump Self-Interest? The Moderating Role of Affect in Extrinsic Incentives (with Uzma Khan and Kelly Goldsmith), *Journal of the Association for Consumer Research*, 2020.

11. "The Uncertain Self: How Self-Concept Structure Affects Subscription Choice," (with Jennifer Savary), *Journal of Consumer Research*, 2020.

12. By-Brand or By-Category? The Effect of Display Format on Brand Extension Evaluation" (with Xiaoying Zheng and Ernest Baskin), *Journal of Retailing*, 2019.

13. "You Don't Blow Your Diet on Twinkies: Choice Processes When Choice Options Conflict with Incidental Goals," (with K. Goldsmith and EMS Friedman), *Journal of the Association for Consumer Research*, 2019.

14. "Apples, Oranges and Erasers: The Effect of Considering Similar versus Dissimilar Alternatives on Purchase Decisions," (with Liz Friedman and Jennifer Savary), *Journal of Consumer Research*, 2018.

15. "Seeing Stars: How the Binary Bias Distorts the Interpretation of Customer Ratings," (w Matt Fisher and George Newman), *Journal of Consumer Research*, 2018.

EXHIBIT A

16. "Effect of Intelligence on Consumers' Responsiveness to a Pro-Environmental Tax: Evidence from Large-Scale Data on Car Acquisitions of Male Consumers," (w Jaakko Aspara and Xueming Luo), *Journal of Consumer Psychology*, 2017.

17. "Proximity of Snacks to Beverages Increases Food Consumption in the Workplace: A Field Study," (w E. Baskin, M. Gorlin, Z. Chance, N. Novemsky, K Huskey, M. Hatzis), *Appetite*, 2016.

18. "Mental Representation Changes the Evaluation of Green Product Benefits," (with Kelly Goldsmith and George Newman), *Nature Climate Change*, 2016.

19. "Closer to the Creator: Temporal Contagion Explains The Preference for Earlier Serial Numbers (with R. Smith and G. Newman), *Journal of Consumer Research*, 2016.

20. "Sophisticated by Design: the Nonconscious Influences of Primed Concepts and Atmospheric Variables on Consumer Preferences," (with T. Andrew Poehlman and John A. Bargh), *Customer Needs and Solutions*, 2015.

21. "Positive Consequences Of Conflict On Decision Making," (with J. Savary, T. Kleiman, and R. Hassin), *Journal of Experimental Psychology: General*, 2015.

22. "The Technological Conundrum: How Rapidly Advancing Technology Can Lead To Commoditization," (with T. Chan and W. Putsis), *Customer Needs and Solutions*, 2015.

23. "When Going Green Backfires: How firm Intentions Shape the Evaluation of Socially Beneficial Product Enhancements," (with G. Newman and M. Gorlin), *Journal of Consumer Research*, 2014.

24. Why Choosing Healthy Foods Is Hard, and How to Help: Presenting 4P's Framework for Behavior Change," (with Z. Chance and M. Gorlin), *Customer Needs and Solutions*, 2014.

25. "Giving Against the Odds: When Tempting Alternatives Increase Willingness to Donate," (with J. Savary and K. Goldsmith), *Journal of Marketing Research*, 2014.

26. Authenticity is Contagious: Brand Essence and the Original Source of Production," (with George Newman), *Journal of Marketing Research*, 2014.

27. "A Dual System Framework to Understand Preference Construction Processes in Choice," (with M. Gorlin), *Journal of Consumer Psychology*, 2013.

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Select Working Papers / Papers Under Review

1. "Ironic Effects of Goal Activation on Choice," (with K. Goldsmith), under first review.

2. "The Effect of Goal Breadth on Consumer Preferences," (with E. Kim), under first review.

3. "Can Investors Multiply and Divide: Investors' response to Stock Splits," (with N. Zhu and Dan Ariely).

4. "Category Expenditure and Promotion: Can Private Labels Expand the Pie," (with W. Putsis), Working Paper.

5. "Mindset over Matter: The Interplay between Goals and Preferences," (with A. Pochepstova), Working Paper.

Conference Proceedings Publications

1. Constructing preferences: The role of comparisons in consumer judgment and choice," (with S. Zhang) *Proceedings of the Association for Consumer Research*, University of Chicago Press (1999).

2. "Sequential Choices and Uncertain Preferences," *Proceedings of the Association for Consumer Research*, University of Chicago Press (1997).

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3. "Causes and Effects of Reference Effects in Choice," *Proceedings of the Association for Consumer Research*, University of Chicago Press (1997).

4. "New Directions in Mental Accounting," *Proceedings of the Association for Consumer Research*, University of Chicago Press (1995).

5. "Decision Difficulty and Uncertain Preferences: Implications for Consumer Choice," *Proceedings of the Association for Consumer Research*, University of Chicago Press (1994).

6. "Behavioral Decision Research: Theory and Applications," *Proceedings of the Association for Consumer Research*, University of Chicago Press (1993).

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Invited and Conference Presentations

Invited Academic Presentations (* denotes multiple presentations)

Boston College
Carnegie-Mellon University
Chinese University, Hong Kong
*Columbia University**
*Cornell University**
*Duke University**
Harvard University
Hong Kong University of Science and Technology
*IIPM**
*INSEAD**
Indiana University
Korea University
*London Business School**
*MIT**
National University of Singapore
*New York University**
*Northwestern University**
Ohio State University
Pennsylvania State University
*Stanford University**
Texas A&M University
Tilburg University
Tulane University
University of Alberta
University of Arizona
University of British Columbia (planned)

EXHIBIT A

*University of California, Berkeley**
*University of California, Los Angeles**
University of California, San Diego
*University of Chicago**
University of Delaware
University of Colorado
University of Florida
University of Houston
*University of Illinois, Urbana-Champaign**
University of Miami
University of Maryland
University of Massachusetts, Amherst
*University of Michigan**
*University of North Carolina**
*University of Peking**
*University of Pennsylvania**
*University of Rotterdam**
University of Texas, Austin
University of Utah
*University of Toronto**
University of Vienna
*Washington University, St. Louis**

Conference Presentations (Over 300 presentations at conferences, consortiums, keynotes, symposiums, workshops, etc.) Recent presentations include:

Keynote Addresses to Practitioners, Various Events
Choice Symposium
CEO Roundtables, New York and New Haven
CMO Roundtables, Various Organizations
ACR
Informs
Judgment and Decision Making
Behavioral Decision Research in Management
Society of Consumer Psychology

EXHIBIT B

Exhibit B

Ravi Dhar's Prior Testimony (past 4 years or more)

1. Delta Air Lines, LLC v. Marriott International, Inc. And Marriott Worldwide Corp (Deposition)
2. Matthew Macormic and Eric Howard v. Vi-Jon LLC (Deposition)
3. Joseph Mier, et al. v. CVS Health and Vi-Jon LLC (Deposition)
4. Orgain v. Iovate, et al. (Deposition and Trial)
5. Jackson et al. v. Anheuser-Busch Companies, LLC and Miami Beer Venture, LLC (Deposition)
6. Girl Scouts of the United States of America v. Boy Scouts of America (Deposition)
7. Ferrari v. Vitamin Shoppe Inc. (Deposition)
8. AT&T Mobility LLC v. Mark Thomann and Dormitus Brands LLC (Deposition)
9. Alfwear, Inc. v. Mast-Jagermesiter US, Inc. et al. (Deposition)
10. State of Washington v. Comcast, et al. (Deposition and Trial)
11. Re: Animal Legal Defense Fund v. Hormel Food Corporation Matter (Deposition)
12. Bay Parc Plaza Apartments, L.P., et. al. v. Airbnb, Inc., et al. (Deposition)
13. Oddo, et al. v. Arcoaire Air Conditioning and Heating, et al. (Deposition)
14. Saxon Glass Technologies, Inc. v. Apple Inc. (Deposition)
15. In Re: Emerson Electric Co. Wet/Dry Vac Marketing and Sales Practices Litigation (Deposition)
16. In the Matter of Satellite Radio and "Preexisting" Subscription Services (SDARS III), Copyright Royalty Board (Deposition and Hearing)
17. Biscotti Inc. v. Microsoft Corp. (Deposition and Trial)
18. FTC v. DirecTV, Inc. (Deposition)
19. Zakaria v. Gerber Products Co. (Deposition)
20. Moab Industries, LLC v. Chrysler Group, LLC (Deposition and Trial)
21. In Re: Tropicana Orange Juice Marketing and Sales Practices Litigation (Deposition)
22. FTC v. Amazon.com, Inc. (Deposition)

23. Ericsson, et al. v. TCL Communication Technology Holdings, Ltd., et al. (Deposition)

24. Parallel Network Licensing v. International Business Machines Corporation (Deposition)

EXHIBIT C

Exhibit C

LIST OF MATERIALS CONSIDERED

PLEADINGS, MOTIONS, AND TRADEMARK REGISTRATIONS

Arm's Complaint and Exhibits, dated August 31, 2022
Qualcomm's Answer and Counterclaims, dated September 30, 2022
Qualcomm's Answer and Amended Counterclaims, dated October 26, 2022
Arm's Answer to Amended Counterclaims, dated November 15, 2022
USPTO Trademark Registration No. 5,692,669 and filed documents
USPTO Trademark Registration No. 5,692,670 and filed documents

DISCOVERY

Arm's Responses and Objections to Qualcomm's First Set of Interrogatories (Nos. 1-11), dated February 27, 2023
Arm's Supplemental Responses and Objections to Qualcomm's First Set of Interrogatories (Nos. 1-11), dated November 17, 2023
Arm's Supplemental Responses and Objections to Qualcomm's Third Set of Interrogatories (No. 20), dated November 17, 2023
Qualcomm's Responses and Objections to Qualcomm's First Set of Requests for Admission (Nos. 1-30), dated October 20, 2023

DEPOSITION TRANSCRIPTS

October 12, 2023 Deposition of Manu Gulati and Exhibits 1-33 thereto
October 27, 2023 Deposition of Will Abbey and Exhibits 19-30 thereto
October 27, 2023 Deposition of Nitin Sharma and Exhibits 1-29 thereto
November 3, 2023 Deposition of Gerald Williams and Exhibits 1-46 thereto
November 9, 2023 Deposition of Paul Williamson and Exhibits 19, 29, 45-74 thereto
November 16, 2023 Deposition of Simon Segars and Exhibits 27, 49, 100-114 thereto
November 28, 2023 Deposition of Mike Roberts and Exhibits 1-6 thereto
November 28, 2023 Deposition of Jim Thompson and Exhibits 1-19 thereto
December 8, 2023 Deposition of Jonathan Armstrong and Exhibits 45, 135-141 thereto

PRODUCED MATERIALS

ARM_00002955
ARM_00002988
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QCARM_2417783

ADDITIONAL PUBLIC LITERATURE AND WEBPAGES

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